



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

PER
6475

Harvard University



DISCARDED BY
GORDON McKAY LIBRARY

GORDON McKAY LIBRARY
Blue Hill Observatory
Collection

TRANSFERRED TO
CABOT SCIENCE LIBRARY

GODFREY LOWELL CABOT SCIENCE LIBRARY

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S.

VOL. V.

1869, NOVEMBER 17, to 1871, JUNE 21.

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.
SEPTEMBER 1871.

RECEIVED
MAR 18 1986
CABOT SCIENCE LIBRARY

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

TABLE OF CONTENTS.

	Page
Names of six Members elected—1869, November 17	1
Three Candidates for admission— <i>ead. temp.</i>	1
 I. On the Summer of 1868. By G. HUNSLEY FIELDING, M.D.	 1
 II. To find the Error in Reading the Cistern-Barometer if not hung truly vertical. By the Rev. W. PREVITÉ, M.A., F.M.S., Little Wrattling, Suffolk. (Woodcut.)	 10
 III. November Meteors, 1869 :—	
W. H. WOOD, Birmingham	11
Royal Observatory, Greenwich	12
Rev. S. J. PERRY, F.R.A.S., F.M.S., Stonyhurst	14
Prof. A. S. HERSCHEL, B.A., F.R.A.S., Glasgow	17
A. FORBES, F.M.S., Culloden	20
 IV. Account of Two Meteors seen at Bishopsbourne, in a letter to J. GLAISHER, F.R.S.	 21
 V. Accounts of a Brilliant Meteor seen on November 6, 1869 :—	
Penzance (J. SENIOR)	22
Penzance (ROBERT BLIGHT)	23
South Devonshire	23
Ramsgate (R. CRAMP, F.M.S.)	23
Broadstairs (JAMES CHAPMAN)	23
Hawkhurst (THOMAS HUMPHREY). (Woodcut.)	24

CORRESPONDENCE, &c.	
	Page
Sound in the Upper Air when the Lower Air is still, in a letter to the Editor. By A. S. HERSCHEL.....	25
Sound in the Upper Air, in a letter to the Editor. By A. S. HERSCHEL.....	27
Names of three Members elected—1870, January 19....	29
Three Candidates for admission— <i>eod. temp.</i>	29
VI. On the Temperature and Humidity of the Air at the Heights of 22 feet and 50 feet above the Ground, in comparison with the Temperature and Humidity of the Air at the Height of 4 feet. By JAMES GLAISHER, F.R.S. (One Plate.).....	29
VII. Rainfall at Jerusalem during the Rainy Season of 1868–69. By THOMAS CHAPLIN, M.D.....	50
VIII. Ozone-Observations	51
CORRESPONDENCE, &c.	
The South-African Exploring Party	52
To find the Error in Reading the Cistern-Barometer if not hung truly vertical. By the Rev. W. PREVIRE, M.A., F.M.S. (in correction of Paper No. II. Proc. 45, Nov. 1869). (Woodcut.)	53
November Meteors, 1869, in a letter to the Editor. By C. MELDRUM	54
Names of three Members elected—1870, February 16 ..	55
Three Candidates for admission— <i>eod. temp.</i>	55
IX. On the Influence of the Moon upon the amount of Rain-fall. By J. C. BLOXAM, M.R.C.S., F.M.S. (One Plate.)	55
X. The Weather of 1869, as observed at the British Cemetery, Scutari, lat. 41° N., long. 29° 3' E. By Sergeant W. H. LYNE, R.E. (Communicated by Rev. R. MAIN, M.A., F.R.S.)	61
XI. On the recent frequent Appearance of the Auroræ. By JAMES GLAISHER, F.R.S.	67
The Aurora Borealis of February 1st, 1870. By the ASTRONOMER ROYAL, Royal Observatory, Greenwich	68

TABLE OF CONTENTS.

v

	Page
XI. On the recent frequent Appearance of the Auroræ (<i>continued</i>):—	
W. ELLIS, F.R.A.S., of the Royal Observatory. (Woodcut.)	68
G. S. CRISWICK, of the Royal Observatory	69
W. C. NASH, F.M.S., of the Royal Observatory. (Woodcut.)	69
THOMAS WRIGHT, of the Magnetical and Meteorological Department, Royal Observatory	70
G. L. SCHULTZ, of the Magnetical and Meteorological Department, Royal Observatory. (One Plate.)	71
WILLIAM MARBIOTT, of the Magnetical and Meteorological Department, Royal Observatory	72
HALE WORTHAM, F.R.A.S., F.M.S., Royston. (Woodcut.)	74
The Magnetic Disturbances at the Royal Observatory, Greenwich, on February 1, 1870	76
The Aurora of February 11, 1870. By G. L. SCHULTZ, Royal Observatory, Greenwich	77
OSMUND AIRY, Wellington College, Wokingham	78
R. C. CANN-LIPPINCOTT, F.M.S., Over Court, near Bristol	78
The Aurora of February 12, appearing in Daylight.	78
The Aurora of February 17	81
The Aurora of February 19	82
The Aurora of February 23	82
CORRESPONDENCE, &c.	
Results deduced from Thirty Years' Observations (1840-69) at Burnham, Westgate, Norfolk. By H. E. BLYTHE, Esq.	83
Abstract derived from Meteorological Observations made at certain Stations in the Colony of the Cape of Good Hope (compiled by a Commission appointed by Government)	84
Names of three Members elected—1870, March 16	87
Five Candidates for admission— <i>eod. temp.</i>	87
XII. On the Fall of Rain on Every Day of the Year, from observations extending from 1815 to 1869. By JAMES GLAISHER, F.R.S. (Woodcut.)	87

	Page
Names of five Members elected—1870, April 20	123
Three Candidates for admission— <i>eod. temp.</i>	123
XIII. On the Rainfall in Natal, South Africa. By R. J. MANN, M.D., F.R.A.S., F.M.S., &c., Superintendent of Edu- cation in the Colony. (Woodcut.)	123
XIV. On some of the Laws which appear to regulate the Tem- perature of Summer Months and Seasons. By GEORGE D. BRUMHAM, F.M.S.	129
XV. Meteorology of Clifton (Bristol) for the Quarter ending March 31, 1870. By A. NORTH, F.R.G.S., F.M.S. ..	136
XVI. Daily Rainfall at Cobham and Chiswick, from 1826 to 1865. By GEORGE DINES, F.M.S.	136
Names of three Members elected—1870, June 15	139
Three Candidates for admission— <i>eod. temp.</i>	139
XVII. Path of the Large Fireball of November 6, 1869, 11 ^h 50 ^m P.M., G. M. T. By Prof. ALEXANDER S. HERSCHEL, B.A., F.R.A.S. (Two Woodcuts.)	139
XVIII. On the Temperature of the Air in Natal, South Africa, from observations taken at Pietermaritzburg (2095 feet above the level of the sea, and in lat. 29° 36' 13" S.) during the Ten Years 1858-67. By R. J. MANN, M.D., F.R.A.S., F.M.S., &c., Superintendent of Education in the Colony	150
XIX. Atmospheric Pressure in relation to Wind and Rain. By RICHARD STRACHAN, F.M.S. (Woodcut.)	158
XX. November Meteors, 1869, in Mauritius. By CHARLES MELDRUM, M.A., F.R.A.S., F.M.S.	161
Réduit, Mauritius (Sir HENRY and LADY BARKLY) ..	162
Myrtle Hill, Mauritius (CHARLES MELDRUM, M.A.) ..	163
Annual General Meeting, 1870, June 15—Report	167
Obituary	186
Papers read	192
Resolutions	193, 197
Balance Sheet	194
Officers and Council	196
NOTICE—Session 1870-71: Meetings	197

TABLE OF CONTENTS.

vii

	Page
Names of four Members elected—1870, November 18 ..	199
One Candidate for admission— <i>cod. temp.</i>	199
XXI. On Evaporation and Evaporation-gauges, with some Remarks upon the Formation of Dew. By GEORGE DINES, F.M.S. (Woodcut.)	199
XXII. On a Storm at Calcutta, followed by a remarkably Hot and Dry Wind. By Lieut.-Col. J. F. TENNANT, R.E., F.R.S., F.M.S. (Two Woodcuts, p. 242.)	213
XXIII. The Aurora Borealis of September 24th, 1870:—	
B. W. SMITH, F.R.A.S., F.M.S.	216
Padre Prof. F. DENZA, Hon. Mem. Met. Soc., Observatoire de Moncalièri, Piémont, Italie	219
October 24th, 1870:—	
WILLIAM C. NASH, F.M.S., of the Magnetical and Meteorological Department, Royal Observatory, Greenwich. (Woodcut.)	221
THOMAS WRIGHT, F.M.S., Mag. and Met. Dept. Royal Observatory	222
WILLIAM MARRIOTT, F.M.S., Mag. and Met. Dept. Royal Observatory	223
GEORGE L. SCHULTZ, Mag. and Met. Depart. Royal Observatory. (One Plate.)	226
W. BISHOP, Mag. and Met. Dept. Royal Observatory..	228
WALTER BARBER, Mag. and Met. Dept. Royal Observatory	228
October 25th and 26th, 1870:—	
WILLIAM C. NASH, F.M.S., Royal Observatory	229
October 25th:—	
THOMAS WRIGHT, F.M.S., Royal Observatory	231
WILLIAM MARRIOTT, F.M.S., Royal Observatory....	231
GEORGE L. SCHULTZ, Royal Observatory	234
WALTER BISHOP, Royal Observatory	236

CORRESPONDENCE, &c.

	Page
Letter from Commander EDMUND H. VERNEY, F.M.S...	237
Extract from a letter from Sergeant LYNE, Scutari, to the Rev. R. MAIN	238
At Sea, off Gibraltar, H.M.S. 'Prince Consort' Capt. G. L. TUPMAN, R.M.A., F.M.S.	239
Cramlington, Northumberland. THOS. SOPWITH, M.A., F.R.S., F.M.S.....	240
 Name of one Member elected—1871, January 18	243
Three Candidates for Admission— <i>eod. temp.</i>	243
 XXIV. Heights and Velocities of Shooting-Stars observed in England in August 1870. By Prof. A. S. HERSCHEL, B.A., F.R.A.S. (Three Woodcuts.)	243
 XXV. On the Remarkable Period of continuous Cold Weather from 1870, December 21st, to 1871, January 5th. By JAMES GLAISHER, F.R.S., Secretary	253
 XXVI. Meteorological Observations in 1869, at Martendale, South- land, New Zealand, lat. 46° 17' S., long. 168° 20' E., height above sea-level 79 feet, distance from sea 10 miles. By C. ROUS MARTEN, F.M.S., Director of Meteorological Stations	258
 XXVII. Description and Figure of Mr. Oator's Anemometer as arranged with Spiral Apparatus. (Woodcuts.)	263

CORRESPONDENCE, &c.

On a Cyclonic Storm. Extract from a Letter from A. V. NURSING RAO to W. HUGGINS, Esq., D.C.L., F.R.S..	266
 Names of three Members elected—1871, February 15 ..	269
Three Candidates for Admission— <i>eod. temp.</i>	269
 XXVIII. Influence of the Moon upon the amount of Rainfall. By JOHN CHARLTON BLOXAM, M.R.C.S., F.M.S. (Wood- cuts.)	269

TABLE OF CONTENTS.

ix

	Page
XXIX. On Professor Poey's New Classification of Clouds. By ROBERT JAMES MANN, M.D., F.R.A.S., F.R.G.S., F.M.S., &c.	276
XXX. The Aurora Australia of October 23 and 24, 1870. By ROBERT JAMES MANN, M.D., F.R.A.S., &c.	281
XXXI. Mean Temperature of the Air at Osborne, Isle of Wight, as deduced from Observations taken during the Years 1858-69 (inclusive). By J. R. MANN.....	282
XXXII. Eclipse of the Sun, 1870, December 22, as observed at Culloden. By ARTHUR FORBES, F.M.S.	282
XXXIII. Meteorological Observations recorded in 1869 at the Ade- laide Observatory, South Australia, lat. 34° 57' S., long. 138° 38' E., height above sea-level 140 ft. By CHARLES TODD, Observer	284
Names of three Members elected—1871, March 15	285
Two Candidates for admission— <i>sed. temp.</i>	285
XXXIV. On Evaporation, Rainfall, and Elastic Force of Vapour. By J. R. MANN	285
XXXV. Abstract derived from Meteorological Observations made at the British Cemetery, Scutari, Constantinople, in the Years 1865, 1866, 1867, 1868, and 1869. Lat. 41° N., long. 29° 3' E. Height above sea 60 feet.....	298
XXXVI. On the Temperature of the Dew-Point. By GEORGE DINES, F.M.S.	299
XXXVII. On a New Electro-Magnetic Anemometer. By JOHN J. HALL, F.M.S.	301
XXXVIII. Results of Meteorological Observations taken at the Observatory, Adelaide, South Australia, lat. 34° 57' S., long. 138° 38' E., height above the sea-level 140 ft. By CHARLES TODD, F.R.A.S., Superintendent of Tele- graphs, and Government Observer	304
Names of two Members elected—1871, April 19	305
XXXIX. On Deep-Sea Thermometers. By Captain J. E. DAVIS, R.N., F.R.G.S. (One Plate and Three Woodcuts.) ..	305

TABLE OF CONTENTS.

CORRESPONDENCE, &c.

À M. le Président de la Société Météorologique. By P.	Page
F. DENZA, Hon. Mem. M.S.	343

Annual General Meeting, 1871, June 21—Report	345
Obituary	364
Papers Read.....	367
Officers and Council	369
Balance-Sheet	370
Resolutions	372
NOTICE—Session 1870-71: Meetings	373

LIST OF PLATES.

PLATE	Page
I. Temperature and Humidity of Air	29
II. Influence of the Moon upon the amount of Rainfall	55
III. Aurora of February 1, 1870	71
IV. Aurora of October 24, 1870	227
V. Deep-Sea Thermometers.....	305

LIST OF WOODCUTS.

Cistern-Barometer. PREVITÉ	10, 53
Meteor of November 6, 1869. HUMPHREY	24
Aurora of February 1, 1870. ELLIS and NASH	69
— — —. WORTHAM	76
Daily Rainfall. GLAISHER	122
Rainfall in Natal. MANN	125
Path of Meteor, November 6, 1869. HERSCHEL	140, 141
Atmospheric Pressure. STRACHAN	160
Evaporation-gauge. DINES.....	212
Aurora of October 24, 1870. NASH	221
Storm at Calcutta. TENNANT	242
Heights and Velocities of Meteors. HERSCHEL.....	245, 246, 249
Anemometer with Spiral-arrangement. CATOR	264
Influence of the Moon on Rainfall. BLOXAM	272, 275
Deep-sea Thermometers. DAVIS.....	338, 340, 342

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1869, NOV. 17.

CONTENTS.

Communications made at the Ordinary Meeting:—

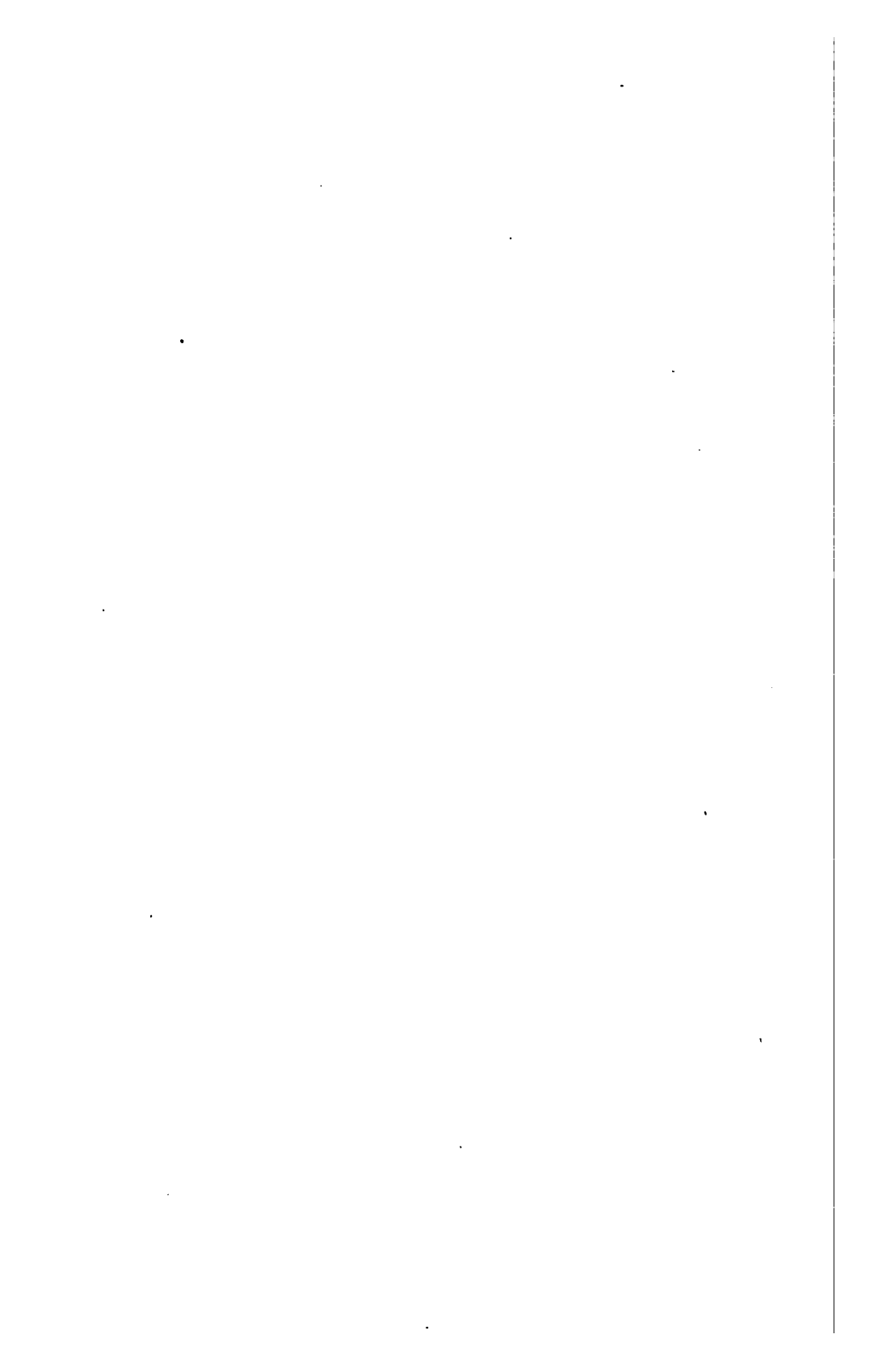
	Page
I. On the Summer of 1868.—G. Hunsley Fielding, M.D.	1
II. To find the Error in Reading the Cistern-Barometer if not hung truly vertical.—The Rev. W. Previt�, M.A., F.M.S.....	10
III. November Meteors, 1869	11
IV. Account of Two Meteors seen at Bishopsbourne, in a letter to J. Glaisher, F.R.S.	21
V. Accounts of a Brilliant Meteor seen on November 6, 1869	22

Correspondence, &c.:—

Sound in the Upper Air when the Lower Air is still, in a letter to the Editor	25
Sound in the Upper Air, in a letter to the Editor	27

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, January.



PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1869, NOVEMBER 17. [No. 45.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Bolton, Jasper, *Ballykisteen, Tipperary*;
Branfill, Capt. B. B., *Great Trigonometrical Survey of India,
Bangalore*;
Chichester, Capt. Harry, *Fartown, Huddersfield, and Junior United
Service Club, Charles Street, St. James's, S.W.*;
Hudson, Henry, M.D., M.B.I.A., *Glenville, Fermoy, County Cork*;
Jervis, Comm. J. J. W., R.N., *Townsend House, Malvern*;
Murray, James, 1 *Royal Exchange, E.C.*;
were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society
were read.

I. *On the Summer of 1868.* By G. HUNSLEY FIELDING, M.D.

THE year 1868 was of so remarkable a character as regards its
summer temperature, which attained the extraordinary height of
100½° in perfect shade (a height which I believe to have been un-
paralleled in this country), that I think its meteorological results

ought to be placed on record, and in no way could they be more appropriately thus treated than by the Meteorological Society.

It is remarkable that this intense heat followed the almost equally intense cold of January 1867, when the shade minimum fell to 5° below zero. The summer may fairly be said to have embraced five months, from May to September inclusive; and the intense heat, combined with great scarcity of rain, was most fatal in its effects both upon the animal and vegetable world. The Registrar-General's returns for the quarter ending September 30 showed a fearful increase, in England alone, of 21,000 deaths.

I propose, in the present paper, to confine my observations to the five summer months; and the following Table will give a concise statement of the marvellous heat:—

Shade Maximum Temperature.

Months.	Number of cases in each Month above								
	60°.	65°.	70°.	75°.	80°.	85°.	90°.	95°.	100°.
May	30	27	22	17	9	7	1	0	0
June	30	30	28	27	20	11	8	1	0
July	31	31	29	27	21	14	9	4	1
August	31	31	27	18	9	6	5	0	0
September ...	30	30	18	10	7	5	2	1	0
Sums	152	149	124	99	66	43	25	6	1

The summer included 153 days, and of these 152 attained 60° and upwards, 149 65° and upwards, 124 to 70° and upwards, &c.

The maxima are also given separately for each month; thus in July there were 21 days when the shade-temperature reached 80° and upwards, 14 of 85° and upwards, 9 of 90° and upwards, 4 of 95° and upwards, and one of 100½°.

A few remarks are necessary as regards the instruments used, and their locality.

My abode is at Tunbridge, in the valley of the Medway; it is nearly surrounded by hills, but the immediate vicinity is flat and marshy, the river winding through, at a distance of about a quarter of a mile, and passing Maidstone to fall into the Thames.

There are some fine old trees about the house, which is situated in its own grounds. A small tributary of the Medway flows at the bottom of the garden to the eastward and southward, on which last there is a millpool through which it runs. The kitchen-

garden is at the back of the house, and in it, entirely detached from the house, is my thermometer-stand. The stand faces to the north-east, a narrow gravelled path separating it from the vegetable beds, and about fifty feet distant is a fruit wall. It is double at the back and top, air circulating freely between the pieces. Behind it is a piece of lawn, and about 20 feet distant a low wall and laurel-hedge fencing off the millpool. The instruments, with which the observations were all carefully taken by myself, are standard ones by Negretti and Zambra, with certificates from Mr. Glaisher*; they are 4 feet from the ground and 75 feet above mean sea-level, as determined by the last Ordnance Survey. The funnel of the rain-gauge is 1 foot above the ground, and 71 feet above mean sea-level.

The barometer is by Barrow, with certificate also from Mr. Glaisher.

In the garden the effects of the heat and drought were remarkable. Nothing whatever came to perfection, either in size or flavour. Peaches and nectarines, apricots, apples, and pears dropped half-developed from the trees; raspberries, currants, and gooseberries hung shrivelled on the bushes, and the beans and peas hung dwarfed or with empty pods. The lawns were burnt quite brown, as were the neighbouring pastures, and often split into deep furrows, the stock being obliged to feed on winter provender. The springs in many places were quite dried up, occasioning great inconvenience and expense in obtaining water. A singular feature I remarked was the comparatively less amount of thunder and lightning than usual in summer, and but one very heavy thunderstorm. The earthquake, though felt at Blackheath, was not perceived here.

The rainfall of the quarter ending April 30 was within 0·2 inch of the average.

And now came in the lovely month of MAY,—

“ Sweet Spring, full of sweet days and roses,
A box where sweets compacted lie.”

And lovely indeed it was, vegetation being a full fortnight in advance. The heat, however, became intense about the middle of the month, the shade-temperature reaching to 93°·8.

* Furnished many years ago.

Temperature of May.

Days.	Temp. in Shade.			Rain.	Days.	Temp. in Shade.			Rain.
	Max.	Min.	Mean Temp.			Max.	Min.	Mean Temp.	
	°	°	°	in.		°	°	°	in.
1	66·6	36·0	51·3		17	78·5	43·0	60·8	
2	76·0	40·0	58·0		18	86·0	50·5	68·3	
3	88·0	44·0	66·0		19	93·8	52·0	72·9	
4	65·5	44·5	55·0		20	78·0	37·0	57·5	
5	60·5	42·0	51·3		21	74·0	52·3	63·2	
6	59·4	31·8	45·6		22	72·0	54·5	63·3	0·05
7	72·0	32·0	52·0		23	62·2	42·0	52·1	0·06
8	85·5	45·0	65·3		24	60·5	55·5	58·0	0·32
9	78·5	43·5	61·0		25	68·0	43·0	55·5	0·11
10	67·0	39·0	53·0		26	73·3	42·3	57·8	
11	69·0	39·0	54·0	0·02	27	78·0	40·8	59·4	
12	73·8	46·0	59·9		28	86·0	49·5	67·8	
13	75·8	47·5	61·8		29	87·8	56·0	71·9	
14	76·3	45·0	60·7		30	85·5	51·0	67·8	0·20
15	82·5	44·0	63·3		31	81·6	41·0	61·3	
16	83·2	49·0	66·1						

Summary of May.

Mean pressure of the air reduced	inches.	29·826
Total amount of rain on six days		0·760
Mean maxima temperature in shade		75·6
Mean minima " " "		44·5
Mean range of " " "		31·1
Adopted mean " " "		58·4
Maximum " " " on 19th ...		93·8
Minimum " " " on 6th ...		31·8
Extreme range in the month		62·0
Maximum mean daily temperature on 19th ...		72·9
Minimum " " " " 6th ...		45·6
Greatest range of " " " 3rd ...		44·0
Least " " " " 24th ...		5·0
Mean degree of moisture		0·73

Remarks.

In this Table we notice the small amount of rain, only 0·76 inch falling, being very nearly $1\frac{1}{2}$ inch under the average; the excessive mean daily maxima being no less than $11^{\circ}·9$ above the average of the last eight years, whilst the minima were $\frac{1}{2}^{\circ}$ under the average. The range of temperature from $93^{\circ}·8$ down to $31^{\circ}·8$, being 62° , was extraordinary. The increase in *mean temperature* was $5^{\circ}·7$.

The month of JUNE was one of marvellous temperature, excessive heat, and excessive drought—

".....*Exustus ager morientibus restuat herbis.*"

The barometer ruled high, and after the drought of May, rain fell only to the amount of 0·43 inch, making in the two months only 1 inch and not quite $\frac{1}{2}$ ths. The extreme heat in shade attained to 96°·7, and the mean-shade maxima to 83°. As in May, the excessive heat was confined to the day, the mean-shade maxima being 14°·2 above the average; whilst the minima were 0°·6 below, and the adopted mean temperature 6°·8 in excess. The amount of rain was 2·31 inches under the average.

In the two months there is a positive average increase of shade-temperature for every day of upwards of 26°! The range of 46° in temperature between day and night in shade, the greatest I have registered.

Temperature of June.

Days.	Temp. in Shade.			Rain.	Days.	Temp. in Shade.			Rain.
	Max.	Min.	Mean Temp.			Max.	Min.	Mean Temp.	
1	87°0	49°5	68°3	in.	16	90°3	52°5	71°9	
2	75°0	48°0	61°5		17	95°5	55°0	75°3	
3	79°4	45°0	62°2		18	78°8	51°0	64°4	
4	65°6	54°0	59°8		19	75°5	52°5	64°0	
5	83°5	44°5	64°0	0°10	20	91°5	55°0	73°3	
6	80°5	53°5	67°0		21	88°6	58°0	73°3	0°02
7	80°6	41°0	60°8		22	69°0	46°0	57°5	0°21
8	72°2	40°0	56°1		23	80°5	43°0	61°8	0°10
9	77°5	41°5	59°0		24	80°0	52°5	66°3	
10	81°0	46°5	63°8		25	83°0	51°3	67°2	
11	84°0	48°0	66°0		26	94°0	48°0	71°0	
12	87°5	50°0	68°8		27	96°7	60°0	78°4	
13	94°6	53°5	74°1		28	82°8	51°0	66°9	
14	90°0	50°0	70°0		29	77°0	45°5	61°3	
15	90°0	51°0	70°5		30	78°0	54°3	66°2	

Summary of June.

Mean pressure of the air reduced	inches.	30°109
Total amount of rain on four days		0·430
Mean maxima temperature in shade		83°0
Mean minima " " "		49°7
Mean range of " " "		33°3
Adopted mean " " "		64°5
Maximum " " " on 27th ...		96°7
Minimum " " " " 8th ...		40°0
Extreme range in the month		56°7
Maximum mean daily temperature on 27th ...		64°6
Minimum " " " " 8th ...		56°1
Greatest range of " " " " 26th ...		46°0
Least " " " " 4th ...		11°6
Mean degree of moisture		0·68

In JULY the heat and drought still persisted with relentless severity. The wind was very light, and principally with an easterly direction, the sky being remarkably clear and bright. The heat attained its acme on the 23rd, when the shade-temperature rose to $100^{\circ}\cdot 5$, being, as far as my knowledge goes, the highest ever attained in England. It sunk in the night to $60^{\circ}\cdot 5$, thus giving a range of 40° and a mean of $80^{\circ}\cdot 5$. The suffocating heat of the 21st and 22nd I shall never forget; the sky was cloudless with scarcely a breath of air, and what there was felt more as if it had passed through an oven. On the 21st the maximum was $99^{\circ}\cdot 4$; but on the 22nd it attained to $100^{\circ}\cdot 5$, and a sun-thermometer on the lawn soon reached 142° , thus giving a range of $81^{\circ}\cdot 5$ with the minimum.

The shade maxima were a mean of $13^{\circ}\cdot 5$ above the average of the last eight years, the mean minimum $3^{\circ}\cdot 6$, and the adopted mean temperature $8^{\circ}\cdot 5$ in excess.

The rain fell only on six days, and amounted to 1·71 inch, being 0·82 inch under the average; and nearly the whole of it fell in two thunderstorms on the 11th and 12th, which yielded respectively 0·77 inch and 0·69 inch.

The mean dryness of the air by two observations at 9 A.M. and 3 P.M. was 0·53.

Temperature of July.

Days.	Temp. in Shade.			Rain.	Days.	Temp. in Shade.			Rain.
	Max.	Min.	Mean Temp.			Max.	Min.	Mean Temp.	
1	74·0	53·5	63·8	in.	17	91·0	60·0	75·5	in.
2	84·0	57·5	70·8		18	88·6	61·6	75·1	
3	81·6	55·0	68·3		19	86·5	51·0	68·5	
4	69·0	43·0	56·0	0·01	20	92·0	58·2	75·1	
5	77·6	51·4	64·5		21	99·4	58·0	78·7	
6	79·0	53·0	66·0		22	100·5	60·5	80·5	
7	87·0	51·5	69·3		23	83·8	54·2	69·0	
8	92·5	54·0	73·3		24	73·0	56·3	64·7	
9	88·5	51·0	69·8		25	76·5	58·0	67·3	
10	85·0	55·0	70·0		26	81·6	57·0	69·3	
11	79·0	58·0	68·5		27	94·5	53·0	73·8	0·01
12	76·2	58·0	67·1	0·77	28	91·0	55·5	73·3	
13	79·6	52·5	66·1	0·69	29	69·4	48·0	58·7	0·19
14	84·0	57·5	70·8		30	84·0	61·0	72·5	0·04
15	96·0	58·0	77·0		31	84·5	46·8	65·8	
16	97·0	61·5	79·3						

Summary of July.

Mean pressure of the air reduced	inches.	30.016
Total amount of rain on six days		1.710
Mean maxima temperature in shade		84.7
Mean minima " " "		55.1
Mean range of " " "		29.6
Adopted mean " " "		68.0
Maximum " " " on 22nd ...		100.5
Minimum " " " " 4th ...		43.0
Extreme range in the month		57.5
Maximum mean daily temperature on 22nd ...		80.5
Minimum " " " " 4th ...		56.0
Greatest range of " " " " 27th ...		41.5
Least " " " " 24th ...		16.7
Mean degree of moisture		0.53

AUGUST was a splendid month, particularly at the commencement. The temperature still continued very high. The day mean maximum was 70.1 above the average, the mean minimum 1.6 , and the adopted mean temperature 58.4 above the average.

Three and a half inches of rain fell, being 1.31 inch above the average. The heavy thunderstorms of the 11th and 12th instants, particularly the latter, which was fearfully violent, and on each of which $\frac{1}{4}$ an inch of rain fell, completely broke up the weather. Another storm occurred on the 17th, yielding 0.85 inch of rain.

The shade maximum only attained 93° and fell to $44^{\circ}.2$, giving a range in shade of $48^{\circ}.8$. Westerly and south-westerly winds predominated.

Temperature of August.

Days.	Temp. in Shade.			Rain.	Days.	Temp. in Shade.			Rain.
	Max.	Min.	Mean Temp.			Max.	Min.	Mean Temp.	
				in.					in.
1	88.0	49.0	68.5		17	69.3	59.2	64.3	0.08
2	91.3	54.5	72.9		18	77.0	60.0	68.5	0.85
3	90.0	55.0	72.5		19	71.0	55.3	63.2	0.50
4	93.0	58.0	75.5		20	71.0	56.6	63.8	0.01
5	92.6	63.0	77.8		21	76.6	52.0	64.3	
6	77.0	65.0	71.0	0.05	22	72.0	53.0	62.5	0.27
7	82.0	53.6	67.8	0.10	23	68.5	46.0	57.3	0.32
8	78.0	49.0	63.5		24	71.0	47.5	59.3	0.01
9	81.3	55.3	68.3		25	72.0	44.2	58.1	
10	87.0	58.5	72.8		26	70.4	39.2	64.8	
11	76.5	52.0	64.3	0.50	27	74.3	44.8	59.6	0.07
12	75.0	49.5	62.3	0.50	28	69.0	50.3	59.7	0.02
13	69.4	48.5	59.0		29	72.0	47.8	59.9	
14	75.5	53.0	64.3	0.17	30	75.0	58.4	61.7	
15	81.8	56.0	68.9	0.04	31	74.4	47.8	61.1	
16	73.2	62.0	67.6	0.02					

SEPTEMBER was perhaps the most singular month of the year. For the first eighteen days no rain fell. A sudden and most extraordinary burst of heat came in the first week, which in temperature was unequalled in the whole of our truly marvellous summer. The mean sun maxima gave for the week $106^{\circ}3$, the shade, maxima $88^{\circ}3$, the minima $50^{\circ}7$. The mean shade range, therefore, was $37^{\circ}6$, and the mean temperature $69^{\circ}5$. The shade maximum of the 6th, $92^{\circ}4$, and of the 7th, $95^{\circ}3$, I never saw equalled in September. The corresponding week of June gave shade maxima $78^{\circ}8$, July $78^{\circ}9$, and August $87^{\circ}7$. The wind was very light and principally easterly.

Notwithstanding the large amount of rain which fell in August, the ground seemed as parched as ever. A large amount of rain fell in ten of the last twelve days of the month, to the amount of 1.91 inch; but that still left an average deficiency of 0.78 inch for the month. The mean shade maxima were $8^{\circ}1$, the mean minima $0^{\circ}9$, and the adopted mean temperature $4^{\circ}5$ above the average. The mean degree of moisture was 78. Easterly winds predominated during the first, and westerly during the second half of the month.

Temperature for September.

Days.	Temp. in Shade.			Rain.	Days.	Temp. in Shade.			Rain.
	Max.	Min.	Mean Temp.			Max.	Min.	Mean Temp.	
1	$80^{\circ}3$	$49^{\circ}0$	$64^{\circ}7$	in.	16	$74^{\circ}5$	$53^{\circ}6$	$64^{\circ}1$	in.
2	$84^{\circ}0$	$52^{\circ}5$	$68^{\circ}3$		17	$70^{\circ}2$	$50^{\circ}0$	$60^{\circ}1$	
3	$86^{\circ}8$	$51^{\circ}0$	$68^{\circ}4$		18	$69^{\circ}3$	$45^{\circ}0$	$57^{\circ}2$	
4	$89^{\circ}8$	$48^{\circ}8$	$69^{\circ}3$		19	$65^{\circ}4$	$54^{\circ}3$	$59^{\circ}9$	
5	$89^{\circ}8$	$50^{\circ}2$	$70^{\circ}0$		20	$72^{\circ}3$	$48^{\circ}0$	$60^{\circ}1$	
6	$92^{\circ}4$	$51^{\circ}6$	$72^{\circ}0$		21	$74^{\circ}4$	$55^{\circ}3$	$64^{\circ}9$	
7	$95^{\circ}3$	$51^{\circ}8$	$73^{\circ}6$		22	$69^{\circ}0$	$49^{\circ}6$	$59^{\circ}3$	
8	$77^{\circ}3$	$57^{\circ}5$	$67^{\circ}4$		23	$70^{\circ}0$	$51^{\circ}0$	$60^{\circ}5$	
9	$71^{\circ}0$	$45^{\circ}0$	$58^{\circ}0$		24	$70^{\circ}0$	$42^{\circ}0$	$56^{\circ}0$	
10	$76^{\circ}6$	$39^{\circ}5$	$58^{\circ}1$		25	$65^{\circ}0$	$52^{\circ}0$	$61^{\circ}5$	
11	$76^{\circ}0$	$48^{\circ}6$	$62^{\circ}3$		26	$70^{\circ}8$	$54^{\circ}0$	$62^{\circ}4$	
12	$69^{\circ}3$	$49^{\circ}5$	$59^{\circ}4$		27	$66^{\circ}3$	$52^{\circ}0$	$59^{\circ}2$	
13	$63^{\circ}0$	$50^{\circ}5$	$56^{\circ}8$		28	$66^{\circ}0$	$53^{\circ}5$	$59^{\circ}8$	
14	$61^{\circ}6$	$53^{\circ}0$	$57^{\circ}3$		29	$66^{\circ}0$	$50^{\circ}5$	$58^{\circ}3$	
15	$65^{\circ}3$	$44^{\circ}0$	$54^{\circ}7$		30	$62^{\circ}0$	$45^{\circ}5$	$53^{\circ}8$	

Summary for September.

	inches.
Mean pressure of the air reduced	29·839
Total amount of rain on ten days.....	1·91
Mean maxima temperature in shade	78°·7
Mean minima " " "	50·0
Mean range of " " "	23·7
Adopted mean " " "	60·5
Maximum " " " on 7th ...	95·3
Minimum " " " " 10th ...	39·5
Extreme range in the month	55·8
Maximum mean daily temperature on 7th ...	78·6
Minimum " " " " 30th ...	53·8
Greatest " " " " 7th ...	43·5
Least " " " " 14th ...	8·6
Mean degree of moisture	0·78

On reviewing these Tables, we find the following extraordinary results for 1868, as compared with the eight preceding years.

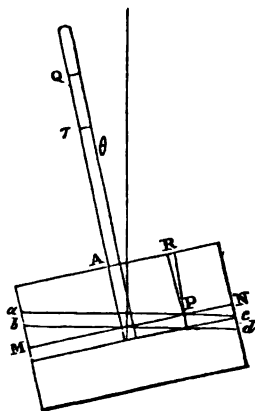
Months.	Temperature in Shade.			Rain.
	Maximum.	Minimum.	Mean Temp.	
				ins.
May	+11·9	-0·7	+5·7	-1·47
June	+14·2	-0·6	+6·8	-2·31
July	+13·5	+3·6	+8·5	-0·82
August	+7·1	+1·6	+5·4	+1·31
September ...	+8·1	+0·9	+4·5	-0·78
Sums	+54·9	+4·8	+30·9	-4·07

We have, therefore, a mean monthly excess throughout the five months as follows, in temperature and decrease in rainfall.

Mean month- ly sums ... }	+10·9	+0·96	+6·15	-0·815
------------------------------	-------	-------	-------	--------

II. *To find the Error in Reading the Cistern-Barometer if not hung truly vertical.* By the Rev. W. PREVITÉ, M.A., F.M.S., Little Wratting, Suffolk.

LET the figure represent the cistern and tube of a barometer hung at an inclination θ to the vertical, RP the pointer, P the zero-point. If the inclination be towards the point, P will be above the true level of the mercury, and the mercury will have to be screwed up to bring the level to the zero-point. The mercury will thus be raised from T to Q in the tube. Let a, b be the radii of the cistern and tube respectively, $\frac{a}{n}$ the distance of R from the axis of the cistern; and let ϕ be the angle between the plane through the axis of the cistern and the major axis of the elliptical surface of the mercury and the plane through the axis of the cistern and ivory point. Then the volume of mercury screwed into (or out of) the tube to bring the level to the zero-point will be the volume of the elliptic lamina ad or $\pi a^2 \times \frac{a}{n} \tan \theta \cdot \cos \phi$. This equals volume QT or $\pi b^2 \cdot QT$.



Therefore $QT = \frac{a^3}{nb^2} \tan \theta \cdot \cos \phi$. Let h, h' be true and apparent heights of the barometer; then

$$h = h' \cos \theta - QT,$$

and error

$$= h' - h = h'(1 - \cos \theta) + \frac{a^3}{nb^2} \tan \theta \cos \phi. \dots (1)$$

This vanishes when $\theta=0$, as it should; and it is a maximum when $\phi=0^\circ$ for any given value of θ ; and when $\phi=90^\circ$, or 270° , the 2nd term vanishes. It is obvious that there will be two values of ϕ between 90° and 270° (θ given) for which the expression (1) is a minimum or vanishes.

Example: let $h'=30$ in., $\theta=2^\circ$, $\phi=45^\circ$, $a=4b$, $b=\frac{1}{4}$ in., $n=2$ (the point being halfway from axis of cistern); then

$$\tan 2^\circ = .0349, \cos 45 = \frac{1}{\sqrt{2}}, \cos 2^\circ = .99939,$$

and

$$h' - h = 30(1 - .99989) + 8 \times .024 \\ = .0183 + .192 = .2103,$$

the error in reading, whence $h = 29.790$.

The error mainly depends on the difference of level in the cistern; and the second term in (1) shows that the error is less the greater π is, or the nearer the ivory point is to the axis of the cistern, and also the greater the radius of the tube is relatively to that of the cistern.

III. November Meteors, 1869.

W. H. Wood, Birmingham.

Nov. 13. P.M. overcast.

Nov. 14. A.M. overcast, except from 1^h to 1^h 15^m, when stars were visible in the south and zenith, but no meteors; afterwards completely overcast.

10^h P.M. clear: no meteors.

11^h „ cloudy.

12^h „ clear; no meteors in half an hour.

Observations resumed at 4^h A.M. of the 15th and continued till 5^h A.M., between which times, with a favourable sky, the following meteors were seen:—

Date, Nov. 15.	Mag.	Colour.	Duration.	Apparent Path.	App. Rad.	Remarks.
h m 4 10 A.M.	1+	White	sec. 0.3	† (γ Leonis and α Canis Minoris) to α Canis Minoris.	L	No train, clear.
4 14 „	1	Yellow	0.5	α Cassiopeæ $\frac{\beta\gamma}{2}$ Andromedæ.	DG ₂	No train, cloudy.
4 32 „	3	Reddish	0.5	γ Cephei, path 25°	L	Red train, clearing.
4 35 „	1+	Yellow	0.5	E.N.E. Altitude 20°, path 15°.	L	No train, clear.

Overcast at 5^h A.M.; no symptom of a meteor shower having been seen.

Observations of Luminous Meteors at the Royal

Month and Day, 1869.	Greenwich Mean Solar Time.	Apparent Size of Meteor in Star-magnitudes.	Colour of Meteor.	Duration of Meteor in Seconds of Time.	Appearance and Duration of Train.	Length of Meteor's Path in Degrees.
Nov. 12.	h m s			s.		°
	11 0 0	.....	.....	.....	.....	.....
	11 25 0	.....	.....	.....	.....	.....
	11 50 0	.....	.....	.....	.....	.....
	12 0 0	.....	.....	.....	.....	.....
	12 10 0	.....	.....	.....	.....	.....
	12 21 43	= Jupiter	Bluish white	1'5	Train	12
	12 30 0	.....	.....	.....	.....	.....
	12 35 35	1	Bluish	1'0	Slight	10
	12 50 0	.....	.....	.....	.....	.....
	12 49 1	2	Bluish white	1'0	Slight	20
	13 0 0	.....	.....	.....	.....	.....
	13 28 34	1	Bluish white	1'0	Slight	10
	13 30 0	.....	.....	.....	.....	.....
	13 37 0	.....	.....	.....	.....	.....
	13 58 2	2	Bluish white	0'5	None	7
	14 0 0	} .....	.....	.....	.....	.....
	15 0 0		.....	.....	.....	.....
	15 0 0		.....	.....	.....	.....
Nov. 13.	11 0 0	} .....	.....	.....	.....	.....
	16 0 0		.....	.....	.....	.....
Nov. 14.	11 0 0	} .....	.....	.....	.....	.....
	11 0 0		.....	.....	.....	.....
	to		.....	.....	.....	.....
	12 30 0	} .....	.....	.....	.....	.....
	11 9 45		1 Bluish white	1'0	Slight	8
	11 51 53		1 Yellowish ...	Rapid	Slight	50
Nov. 15	12 15 45	2	Bluish white	0'7	None	10
	13 0 0	.....	.....	.....	.....	.....
	10 21 26	2	Bluish white	0'5	None	15
	11 46 30	1	Bluish	0'5	Slight .....	.....
	11 48 20	2	Bluish white	0'7	None	12
	12 0 17	2	Bluish white	0'7	Slight	20
	12 15 20	1	Yellow	1'0	Train	28
	12 17 22	1	Yellowish ...	1'5	Very fine, 1 st	30
	12 35 0	2	Blue	1'0	None	6

The observers were Messrs. Nash, Wright, Schultz, Marriott, Barber, and

Observatory, Greenwich, November 12-15, 1869.

Path of Meteor through the Stars.	Observer.
Watch commenced: sky overcast Clouds breaking, stars dimly visible Again cloudy Generally cloudy: thin clouds in zenith Clearing rapidly From direction of Capella, disappeared about 1° from Polaris Sky nearly cloudless. From a point about 1° below Jupiter, passed towards η Piscium ... Thin clouds coming over from N. and W. From direction of μ Ursæ Majoris, passed about 1° above ν Ursæ Majoris. Thin clouds prevail. Fell vertically towards the horizon from a point about midway between γ and ζ Leonis. Generally cloudless. Very cloudy. From β Arietis; fell with inclination to left, about 30° from vertical. Occasional breaks. Overcast onwards. Watch commenced; during the whole of the night the sky was generally overcast, with slight breaks at intervals. No traces of meteors seen. Watch commenced. Partially cloudy. From about 1° above κ Geminorum towards horizon; path prolonged backwards, would cross β Tauri. From the direction of Castor, passed across the zenith towards δ Andromedæ. From the direction of β Tauri, fell to a point 6° below Pollux. Overcast onwards $14\frac{1}{2}^h$. Thin rain falling. From κ Cephei, fell towards κ Lyræ From a point midway between Jupiter and the Pleiades, fell almost perpendicularly towards horizon. From a point midway between κ and δ Ceti, fell towards the horizon at an inclination of 30° from vertical. From a point near μ Tauri, disappeared about 5° below δ Ceti..... Passed midway between ϵ and ζ Orionis to a point a few degrees above κ Ceti. From λ Geminorum, disappeared between ζ and ϵ Orionis From a little below κ Persei, disappeared about 6° above β Orionis.	N. N. M., S. W. W., M. M. N. W. W., M. N., M. M. J. B. M. M. J. B. M. J. B.

Bishop, represented by the initials N., W., S., M., J. B., and W. B.

Rev. S. J. PERRY, F.R.A.S., F.M.S., Stonyhurst.

Nov. 13, 10 P.M. Sky overcast; no probability of a good break in the clouds.

Nov. 14. The moon shone brightly until a heavy cloud obscured it at 2^h 15^m A.M.; it then remained hidden until its setting.

The sky was rather hazy all night, and towards 3^h A.M. the haze thickened considerably.

Unfortunately the clouds were generally more numerous in the E. than elsewhere, and consequently the constellation of the Lion was not unfrequently obscured.

Representing a totally overcast sky by 10, the amount of cloud during the course of the night was

		h	m	h
3	 from	10	0	to 12 P.M.
5	 at	0	30	A.M.
1	 at	1	0	„
8	 at	2	0	„
1	 from	3	0	to 4 A.M.;

and after 4^h A.M. the clouds gathered quickly, until it became perfectly overcast at 4^h 50^m.

The fall of dew during the night was heavy; and there was a continuous breeze from the W.S.W.

Four observers divided the sky between them, and remained at their posts during the greater part of the night.

The results of their observations may be summed up in the following Table.

The positions given can only be considered as fair approximations.

TABLE.

Greenwich Mean Time.	Magnitude.	Direction.	Remarks.
d h m s			
Nov. 14 10 39 0 P.M.	Small	From Auriga towards E.	
10 52 0 "	"		
11 20 0 "	"	From α Orionis to Twins.	
11 30 41 "	"	From Cassiop. towards W.S.W.	
11 38 0 "	"	From zenith through Cassiop.	
11 41 31 "	"	From zenith to shoulders of Orion.	
	"	From Capella towards Castor.	
11 54 0 "	"	From Twins through belt of Orion.	
Nov. 15 12 4 0 A.M.	"	From γ Geminorum towards horizon.	Path 15°.
	Brilliant.....	From Polaris to Vega	(Time not noted).
12 45 46 "	Bright	From Pointers to Mizar.....	Train 10°, pale greenish white.
12 58 0 "	Small	From Pointers to Pollux.....	Path 10°, a train.
1 0 0 "	"	From 2° E. of zenith towards Castor.	
1 0 3 "	"	From Auriga to zenith.	
1 12 6 "	"	From β Urs. Maj. to zenith.	
	"	From κ Geminorum to γ Orionis (Path not well noted)	} A few seconds after previous meteor.
1 16 26 "	Bright	Capella to Castor	
1 18 0 "	Small	(Path not known).	Path 10°. Pale train.
1 21 0 "	"	From β Orionis to Pointers.	
1 25 0 "	"	From Cassiop. towards Pollux.	
1 49 6 "	"	From Castor to Orion.	
1 59 16 "	Very bright	From 9° E. of Urs. Maj. passing between Pointers.	Path 30°. Its train appeared broader at its centre and of a reddish tint, the rest of the train being of a pale greenish white.
2 9 0 "	Small	From Leo towards tail of Ursa Major.	
2 11 0 "	1st mag.....	From zenith towards N. horizon	Path 10°.
2 15 0 "	Small	From γ Leonis to E. horizon.	
2 20 0 "	"	From Pointers towards Leo.	
2 22 41 "	Bright	From near Pollux towards Ursa Major.	Path 20°. Train of a pale greenish colour.
2 30 0 "	Small	From belt of Orion towards W. horizon.	
2 30 41 "	"	From κ to β Orionis.	
2 31 40 "	Faint	From γ Leonis towards tail of Ursa Major.	
2 35 0 "	"	From Twins towards Polaris.	
2 37 56 "	Very bright	From γ Leonis towards horizon.	

TABLE (*continued*).

Greenwich Mean Time.	Magnitude.	Direction.	Remarks.
d h m s			
Nov. 15 2 38 36 A.M.	Faint	From near γ Orionis northwards	Path 20°.
2 42 0 "	Small	From zenith towards W. horizon.	
2 44 0 "	"	} Direction not well observed.	
2 50 41 "	"		
2 51 13 "	"	From γ Leonis towards η Ursa Majoris.	
2 55 40 "	"	From γ Leonis towards ζ Ursa Majoris.	
	"	From centre of Orion's belt to- wards Rigel.	
	Bright	From near μ Leonis towards Twins.	Train 30°, pale.
	"	From near μ Leonis towards tail of Ursa Major.	Train.
3 3 0 "	Small.		
3 5 0 "	"	From slightly E. of γ Ursa Ma- joris towards E. horizon.	
3 9 26 "	Bright	From γ Leonis towards zenith.	Path 25°. Train visi- ble 3°.
3 10 56 "	"	From zenith to Leo.	
3 12 0 "	Small	From zenith to Pointers.	
3 16 0 "	1st mag.		
3 17 0 "	Small	Across belt of Orion from E.	
3 19 0 "	"	From zenith to η Leonis.....	Faint train.
3 22 0 "	Bright	From Pointers towards Twins...	Pale yellow train.
3 22 41 "	Small.		
3 23 0 "	"		
3 24 30 "	"	From Twins towards Pleiades.	
3 28 40 "	Very bright	From Capella to Procyon.	
3 32 26 "	Small	From Polaris to Ursa Major.	
3 33 26 "	Bright	From zenith.	
3 36 0 "	"	From Pleiades towards N.W....	Path 20°. Broad train.
3 38 40 "	Small	From Regulus towards Twins.	
3 40 0 "	"	From μ Leonis to Procyon.	
3 56 0 "	"		
4 3 0 "	"		
4 3 24 "	"		
4 4 0 "	Bright	In Leo.	
	"	In Leo.	
4 6 15 "	Very bright	From Leo towards a point some- what E. of the Pointers.	Lit up garden. Visi- ble 30°.
4 9 30 "	Bright	From Capella to Cassiopeia.	
4 11 30 "	"	From Pleiades to S. horizon.	
4 16 46 "	Small	From between α and η Leonis.	
4 21 55 "	"	From Aldebaran	Curved path.
4 35 0 "	Very bright	Across Leo	Lit up the clouds.

The prevailing colour of the larger meteors was a pale greenish white. Several of the trains were curved.

Most of the brilliant meteors were seen after 4^h A.M., when the

sky was rapidly getting overcast, and hence we may conclude from the above Table, however imperfect it may be on account of the clouds, &c., that the maximum display would probably have occurred at a somewhat more advanced hour of the morning.

Prof. A. S. HERSCHEL, B.A., F.R.A.S., Glasgow.

In spite of the very stormy weather here, and in the north generally, on Saturday night we obtained some good observations of the shower of November meteors between 4^h 30^m and 5^h 30^m A.M. on Sunday morning. Mr. Robert McClure was fortunate to catch the sky clear during that interval, and noted down the tracks of nearly thirty meteors in 1^h 50^m upon a map while observing from within doors through a window. This will explain why the tracks recorded are confined to one half of the sky, and chiefly to the constellations between Ursa Major and Leo. The *beginning* of the large fireball at 4^h 47^m was, for the same reason, not seen until it passed α Cephei, and from that point until it burst near $\frac{\beta, \eta}{2}$ Draconis, its duration, while in sight, was 4 seconds, well counted, or *very slow* in speed. It was therefore *not* one of the Leo meteors! but an accidental or *casual* member of some other meteoric shower appearing simultaneously with them! Its position near the north horizon was not, I am afraid, very favourable for the generality of observers elsewhere.

Allowing for those which he saw and did not map down, and for the time spent in noting those which he recorded, Mr. McClure thinks that the number visible from his point of view was about sixty per hour, and as this was in a very confined part (not more than one-third of the sky, which was without clouds), the hourly number between 4^h 30^m and 5^h 30^m must have been at least 150. He could not note any increase of frequency in the short time of his watch; nor were any meteors seen with very long-enduring streaks. Those streaks noted in the list hardly endured longer than the flight of the nucleus itself, and disappeared almost at the same time as the head. There was no moon shining during the time of his observations; but if his window was shut (which I do not know), it would very much diminish the light of the streaks.

Date.	Hour. A.M.	Apparent Size.	Colour.	Duration.	Position.
1869. Nov. 14.	h m			s	
	3 49	= 1st-mag. *	White.....	0.3	From 67 Ursæ Majoris to κ Boötis.
	4 15	= 2nd-mag. *	White.....	0.5	From ι Ursæ Majoris to χ Draconis.
	4 20	= 1st-mag. *	White.....	0.3	From O Camelopardi to κ Cephei.
	4 25	= 1st-mag. *	White.....	0.6	Centre at $\frac{1}{2}(\iota + \epsilon)$ Leonis
	4 28	= 1st-mag. *	Yellow	0.4	From $\frac{1}{2}(\epsilon, \eta)$ to ξ Boötis
	4 30	= 1st-mag. *	White.....	0.5	From m Leonis Minoris to ϵ Leonis.
	4 31	= 2nd-mag. *	White.....	0.5	Commenced at $\frac{1}{2}(\lambda, f)$ Canum Venaticorum.
	4 32	= Venus	White.....	0.3	From λ Draconis to κ Cephei...
	4 34	= 1st-mag. *	White.....	0.5	From ι Ursæ Majoris to Q Camelopardi.
	4 35	= Jupiter ...	White.....	0.3	From $\frac{1}{2}(a, 5)$ Canum Venaticorum to $\frac{1}{2}(\theta, \lambda)$ Boötis.
	4 36	= 1st-mag. *	White.....	0.5	From 5 Canum Venaticorum to $\frac{1}{2}(a, 21)$ Canum Venaticorum.
	4 37	= 1st-mag. *	White.....	0.4	From f to o , Canum Venaticorum
	4 40	= Venus.....	White.....	0.3	From $\frac{1}{2}(a, 5)$ Canum Venaticorum to η Ursæ Majoris.
	4 41	= 1st-mag. *	White.....	0.5	From near 67 Ursæ Majoris to $\frac{1}{2}(a, 5)$ Canum Venaticorum and 5° further.
	4 43	= Jupiter ...	White.....	0.5	From 21 Canum Venaticorum to κ Boötis.
	4 45	= 2nd-mag. *	White.....	0.4	From $\frac{1}{2}(f, \lambda)$ Canum Venaticorum to a point on a line towards γ Boötis half as far onwards as that star.
	4 47	= $\frac{1}{2}$ apparent diameter of the moon.	Red.....	4.0	From κ Cephei to $\frac{1}{2}(\beta, \eta)$ Draconis.
	4 59	= 2nd-mag. *	White.....	0.4	From $\frac{1}{2}(\eta$ Ursæ Majoris, 5 Canum Venaticorum) to κ Boötis.
	4 59	= 2nd-mag. *	White.....	0.4	.....
	5 2	= 1st-mag. *	White.....	0.6	From near λ Draconis to κ Lyrae.
	5 6	= Venus.....	White.....	0.5	From χ Ursæ Majoris to $\frac{1}{2}(83$ Ursæ Majoris, κ Draconis).
	5 23	= 1st-mag. *	White.....	0.5	From $\frac{1}{2}(\gamma, \beta)$ to κ Herculis ...
	5 26	= 2nd-mag. *	White.. ...	0.4	From m Leonis Minoris to ϵ Leonis.
	5 29	= Venus.....	Red.....	0.5	Began close to κ Cephei and 10° beyond that star.
	5 35	= 2nd-mag. *	Red.....	0.3	From λ Ursæ Majoris to $\frac{1}{2}(a, 5)$ Canum Venaticorum.
	5 36	= 1st-mag. *	White.....	0.2	From 17 to λ Herculis.....
	5 39	= 2nd-mag. *	White.....	0.3	Shot across κ Herculis and 5° further.

Appearance.	Length of Path.	Direction.	Remarks.
Left a streak for 0.6 second.....	0	Radiant α Leonis.	
Left no streak .....	.....	Radiant in Leo.	
Left a streak for 0.8 second.....	.....	Directed from Leo.	
Left a streak for 0.5 second.....	20	Directed from ϵ to l Leonis.	
Left no streak.....	20	Directed from Regulus.....	Centre of path close to Arcturus.
Left a streak for 0.4 second.....	.....	Directed from ζ Leonis.	
Left no streak	Shot half-way to δ Boötis.	Directed towards δ Boötis	From Radiant α Leonis.
Left a streak for 0.5 second.....	.....	Directed from γ Leonis.	
Left a streak for 0.4 second.....	.....	Directed from ϵ Leonis.	
Left a streak for $\frac{1}{2}$ a second.....	.....	Directed from α Leonis.	
Left no streak .....	.....	From Radiant in Taurus.	
No train or sparks .....	.....	Directed from Regulus.	
Left a streak for 1 second .....	.....	Directed from ζ Leonis.	
Left a streak for 0.8 second.....	.....	Directed from ζ Leonis.	
Left a streak for 0.5 second.....	.....	Directed from ζ Leonis.	
No train or sparks .....	.....	Directed from Lynx and Cancer.	
Decreased in brightness near the middle of its path; then brightened up, and burst shortly after. [Observer forgot, while listening for an explosion, to note if any streak was left.]	30	Rose upwards in the northern sky (!).	At bursting the last fragment appeared to turn sharply off from its straight course, and disappeared. I heard no explosion.
Left a white streak for 0.4 second			
Left a white streak for 0.5 second			
Left a streak for 0.4 second.....	.....	Directed from Denebola.	
Left a streak for 0.6 second.....	.....	Directed from ζ Leonis.	
No train or sparks .....	.....	[Directed from Taurus ?]	
Left a streak for 0.2 second .....	.....	Directed from ζ Leonis.	
Left a red streak for $\frac{1}{2}$ a second	10	From the Leo Radiant.	
No train or sparks .....	.....	Directed from Gemini.	
No train or sparks .....	.....	From the Radiant in Leo.	
No train or sparks .....	.....	From the Radiant in Leo.	ROBERT M'CCLURE, Observer.

I watched through a window until 2 o'clock on Sunday morning without seeing any *flashes* of light through the clouds and rain; and at 4 o'clock, when I went to bed, it was still raining and overcast. I could not therefore use the spectroscope.

On Sunday night and Monday morning the sky was beautifully clear from 12 o'clock until nearly 2 o'clock A.M. without a single meteor being seen, although I was watching for them with the spectroscope. A small one which appeared at 11 o'clock was the only meteor which I saw on that night; and I went in doors at 2 o'clock, and left off observing any longer.

"Total number seen by one observer in a generally clear sky, no moon = 60, = 40 per hour.

"The durations of the meteors were very short. Why?"—
(B. M^cCLURE.)

[The sky was clear during the observations in the part towards east which was in view, and the moon was set. About one-third of the sky was visible, and nearly half of the time was lost in mapping the meteors. The number visible, had the observer watched continually, would have been at the least 60 in an hour.—(A. S. H.)]

A. FORBES, F.M.S., Culloden.

The "shower of meteors" was seen here to considerable advantage on the morning of the 14th. Between the hours of 3 and 7 (Greenwich time) upwards of 200 were counted, the maximum part of the shower appearing to occur about 5 o'clock. While the greater number of meteors emanated from the constellation Leo, many came from Perseus, Cassiopeia, and Cepheus, and some from Draco, and other constellations. The meteors generally shot forth two or three together, at intervals of from 30" to 45", their course being downwards, or towards the horizon, with the exception of one which came from Perseus. This meteor shot across the zenith from W.S.W. to E.N.E., the nucleus, which was about the size of Jupiter and intensely bright, bursting in two before it disappeared. The time of its occurrence was 4^h 48^m. None of the meteors, with the exception of the one just described, had trains of more than 10° in length, and different from those in the remarkable shower of 1866; the duration of their visibility did not exceed 5". The colour of the nucleus of the meteors on this occasion was that of the stars; but a few of them had hues of red, blue, and greenish light. The night of the 13th was mild, with a temperature not lower than 44°·8. The

wind blew briskly from the S.W., with occasional showers of rain till midnight, the barometer reading 29·364 (corrected) at 11 hours, and still falling.

IV. *Account of Two Meteors seen at Bishopsbourne, in a letter to J. GLAISHER, F.R.S.*

Bishopsbourne Rectory, Canterbury,
October 20, 1869.

MY DEAR GLAISHER,—I have just read in 'The Standard,' Saturday, October 16, an account of the meteor of the preceding Monday which was observed at Heighington, Sheffield, and London, and was probably vertical at a point about thirty miles south of Sheffield. It was seen here, at Bishopsbourne, from the Rectory garden, by my niece, Miss Reade, and I find that the point of its observed disappearance behind a large tree on the horizon is about 40° west of north, having 6° of altitude. It had no illuminating power, though the colour was bright yellow, and the magnitude something less than the apparent size of Jupiter. This observation tends to confirm the calculations in 'The Standard.'

On the evening of the 1st of this month, at about 8^h 12^m 30^s Greenwich mean time, I was the fortunate observer of another meteor of surpassing splendour. Its path was nearly vertical, with a slight easterly deviation, from Algenib to a point about 5° above the horizon, and about 60° east of south. It did not bound and rush into extinction like an echo to the grand old Poet's words,

ἔπειτα πηδόνδε κυλινδετο λάας ἀναιδής

("Thunders impetuous down and smokes along the ground");

but slowly and majestically descended, not fell, from its celestial throne till it vanished suddenly and noiselessly within mortal ken. The body of the meteor seemed to increase in size as it approached the earth, and gave the observers (myself and the two gardeners) the impression that it was between us and the horizon. It illuminated the whole of the Barham Downs and valley with its bright magnesium light, and for the last three seconds it left a train of intense brilliancy, about four times the length of its major axis, a dazzling blue and red dividing the train in about equal portions. The light of the body, which was egg-shaped and about half the size of a gibbous moon, was extinguished in a moment, and the effect was startling. It was slightly in advance of its train before it vanished, and the red end of the train was the last to disappear.

I was preparing to observe Jupiter with my fine old Tulley Newtonian, which Browning has lately perfected by adding a plane silver speculum instead of the Cuthbert speculum, and our attention was suddenly arrested by this remarkable meteor, which seemed in a moment to convert night into day. Of the many meteors I have observed, this is emphatically the one to be remembered. The time of visibility was about 7 seconds.

Yours very faithfully,

J. B. READE.

V. *Accounts of a Brilliant Meteor seen on November 6, 1869.*

PENZANCE.

Extract from Dispatch received from Telegraph Clerk at Penzance Station.

"R. H. SCOTT, Esq.

"DEAR SIR,—At 6^h 55^m P.M. last (Saturday) night, a meteor of unusual brilliancy was visible here. It first appeared from the east in the shape of a rocket, and after travelling a short distance westward, shot out red, white, and blue balls.

"The country was lit up with a pale blue electric-like light, but very bright, indeed almost as light as day. It gradually disappeared in a zigzag serpent-like shape. The whole appearance lasted about twenty mins. The weather was very moderate, with a light, cold, northerly breeze.

"Barometer rising, stood at 29.97.

"Yours respectfully,

(Signed)

"J. SENIOR."

PENZANCE.

The following is a copy of a letter to the Astronomer Royal.

SIR,—At $\frac{1}{4}$ to 7 (Greenwich time) on Saturday evening the 6th instant, a very remarkable meteor passed over this town and neighbourhood; at its explosion, the gaslights in the streets paled, and in well-lit business establishments its extraordinary brilliancy was clearly distinguished; many persons went into the streets to discover what had occurred; immediately after the explosion a long train resembling a cloud near the horizon at sunset remained, bespangled at first with a vast number of brilliant points or stars; at that time it lay across Perseus and moved in the direction of Cassiopeia, which it crossed. All the principal stars were visible during its passage; the motion was from south-east to north-west, a gentle breeze at the time from the latter point not retarding

its progress ; I observed this cloudy train for three-quarters of an hour, its dimensions and colour decreasing until it reached the head of Cepheus, when it finally disappeared ; the evening sky was clear, Jupiter was shining beautifully ; the Moon and Venus in conjunction illumined the western sky as they descended toward the Atlantic Ocean.

I am, Sir, Yours most obediently,

 ROBERT BLIGHT.

SOUTH DEVONSHIRE.

A meteor of unparalleled magnificence was seen on Saturday (Nov. 6, 1869) evening. It shot from a point a few degrees east of the zenith, sped across the sky westwards, and disappeared about 80° above the horizon. The broad trail of light that marked its course was visible for about twenty minutes. A tremendous ball of fire appeared as the meteor faded, giving a light, says one telegram, "equal to daylight," and after about five minutes burst into various colours.

RAMSGATE.

DEAR SIR,—Herewith I give you a description of the "meteor" as seen here (Obs. T. F. Stead) on the evening of the 6th of November, at 6^h 47^m P.M. It started just below Vega at 55° altitude, passing through arm of Hercules and between head of Hercules and Ophiuchus, α Ras Alhague and α Ras Algethi, exploding at 15° from horizon ; trail lasted over twelve minutes. Colour at first yellow, then blue, followed by red, orange-red, after explosion to violet, &c. ; no noise heard ; at first the size of the planet Jupiter, but afterwards half the size of a full moon ; trail perpendicular, but at finish turned to right hand, thus }, observer being face to W.

I am, dear Sir, Yours faithfully,

 R. CRAMP, F.M.S.

BROADSTAIRS, JAMES CHAPMAN.

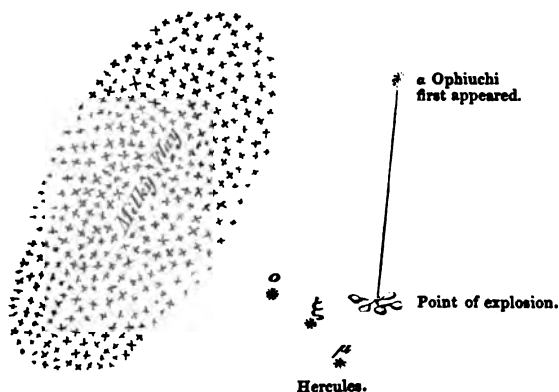
On the evening of the 6th, at about 7^h, walking from Ramsgate to Broadstairs, about midway between the two towns, my face being to the N.E., a strong reflexion of light from the ground caused me to turn quickly, when I saw in the S.W. what had all the appearance of a brilliant rocket, but descending nearly vertical. The inclination from the vertex being about 2° north, in its descent, it must have passed over the star β Ophiuchus, that being the position of the stationary train which continued visible

over a minute. Not seeing the commencement, I am not able to give so good a description as I could wish; but the bright flash which attracted my notice was but momentary, the body continuing its very rapid motion below the horizon, the whole occupying scarcely 2 seconds.

HAWKHURST.

SIR,—I was fortunate enough to witness the appearance of a splendid meteor on Saturday evening. I was walking from the Moor towards Highgate at 6^h 50^m P.M., or thereabouts, and a bright light suddenly appearing all around me, caused me to turn, and I saw at that moment a meteor in the act of exploding. I can compare it to nothing so nearly like the explosion of a sky-rocket high up in the air, and which, on the spur of the moment and being the time for fireworks, I considered it to be.

I saw several fragments flying apart as in the explosion of a rocket; they appeared to be of different colours, some blue, others orange-coloured and white; and above this spot there was the train of light caused by the motion of the meteor, standing like a slender pillar of fire quite *perpendicularly*, and reaching to the star α Ophiuchi. A small luminous cloud like a "nebula" was visible for several minutes at the spot where the meteor had disappeared. The direction from Hawkhurst was nearly west. I particularly noticed the extreme rapidity of the meteor's flight, and its perpendicular direction towards the earth. I annex a diagram of the meteor's course.



The star α Ophiuchi appeared to be about 20° above the horizon.

I am, Sir, Your obedient Servant,

A. Herschel, Esq.

THOMAS HUMPHREY.

CORRESPONDENCE, &c.

To the Editor of the Meteorological Society's Proceedings.

Collingwood, Hawkhurst,
May 19, 1869.

DEAR MR. GLAISHER,—As I was out to-day in a riding party between here and Cranbrook, we all heard together that loud but dull sound like continuous thunder (but very distant), which I once before described to you in an account which was printed in the Proceedings of the British Meteorological Society for February 17, 1864, as “sound in the upper air when the lower air is still.” It was like the constant rumbling of a heavy cart near at hand, and resembled the drumming of an immense winnowing machine so much, that we turned aside from the road to a farm in a field close by, to see if a winnowing machine was at work there. The barn was a good one for a view, and there was nothing to be seen of the kind in all the country round; but the sound was quite distinctly audible between the heavy gusts of wind which were blowing very frequently, and which made a perfectly different sound in the boughs of the large trees by the roadside and in the hedges, which I at first thought might explain it when we would approach the largest of them in our ride. The sound continued, quite uniform, at all distances from trees or houses, and was chiefly heard in the lulls of the wind, but was sometimes audible above it. It lasted about ten minutes while we listened to it; and was louder than the humming which a thrashing-machine often makes, but very like it in character. The *direction* was very difficult or even impossible to assign. It seemed to be *in* the air, but I could not say that it seemed to come distinctly from overhead, more than *from all* parts of the horizon *and* above us! We heard it first at about 3^h 20^m P.M., and after riding about a mile it no longer attracted our attention. On returning to the same spot at about 6 o'clock, the sound was heard again, but *much fainter*, and the weather was still blustering, but more settled wet than before. The direction of the wind at this spot, on the slope of a valley which runs S.E. to N.W., was, I think, more southerly than we found it on the high ground where it was due west, and the eddy in the valley may have occasioned the sound. I cannot say that there was no thrashing-machine at work in the valley or up the wind, but we saw none near enough to account for the imposing, and what I called in my former account the “awe-

inspiring" character of the sound. It resembled most nearly, as I stated there, "the noise of the spinning-mills which can be heard in some of the streets of Leeds;" but the other descriptions contained in that account, like a distant storm or the action of the sea before a gale, or the *roar of a luggage-train, but for its continuing so long*, are equally good representations of the reality. At the first sound the sky was clear blue and thickly filled with cumuli and low scud, driven rapidly across from W. to E. The cumuli seemed to be considerably more stationary than the scud. A very heavy black storm was passing along the whole N. horizon, very low and distant.

May 21st.—Yesterday I made inquiries at every farmhouse in the neighbourhood to the windward of our place of halting, on our ride, to hear the sound; and no thrashing-machine or winnowing-machine was in use on that day for three or four miles in that direction, or for several miles in any direction, as far as I could learn, or to the knowledge of those farmers to whom I spoke about it here, anywhere in the neighbourhood. I found that about the time of the sound a "thrasher" (thrashing-machine) was travelling along a road about a mile or a mile and a half distant to windward of our station, but it was not working; and the farmer, Mr. Reeves, who was bringing it home, says that the rumbling noise which it makes on the country roads cannot be heard much further than a few fields off, or than that of a heavy waggon. Another explanation of the sound which I heard this morning from the farmer (and millowner), Mr. Ayerst, on whose ground we were posted at the time of the sound, is, that it was the wind among the hoppoles, which are very *bare* at this time of the year, and the road where we were, passes exactly between two very large hop-gardens, by the skirts of one of which we also rode off the road to examine the barn beside it. Farmers are now very busy in these parts tying the young hops to the poles, and are therefore familiar with the monotonous sound of a strong wind among the poles (like that of a wind on telegraph-posts or in a ship's rigging, but more hollow and deeper). The sound which we heard again at 6 o'clock may have arisen from this cause; and I will visit the same place on another windy day to see if the sound, as Mr. Ayerst assured me, is a usual one. I doubt, however, that the strongest disturbance of the poles and of the wind, by themselves, could produce a sound so like thunder, and lasting for such a length of time. On continuing my walk this morning

to the dairy-farm of Mr. Goschen, M.P. (who is building a new house on an estate near here), further S.W. than the road where the thrashing-machine was passing on Wednesday, and where I heard yesterday that the sound was heard, the bailiff's wife told me that in a cottage some distance off it was also heard. I asked there, and learned that the children were so startled by the noise, that they thought it was workmen blasting the rocks for stone in the quarry near these houses. They were quieted by the women, who thought that it was thunder, but wondered that it lasted such a long time*. These cottages are at least two miles from the place where we heard the sound. I cannot describe the sound better than that of a great waterfall like Scale-force in Cumberland, which I once visited, and we found our way to it from some distance by following the direction of the sound, descending as it does in such a cleft of the rock as to be invisible anywhere excepting from the mouth of the chasm. Another explanation of the sound, which our drill-serjeant suggested to me today, is, that the militia artillery practice at Bleckenham (?), in the direction of Hastings, has been heard from here constantly during the two last afternoons; but this would give an interrupted sound.

My impression is that it was a very distinct repetition of the sound of the "sighing or moaning of the wind heard as preceding a storm," which you describe in the "Eleventh Balloon Ascent," on the 26th of June 1863, at a height of 8888 feet, as heard for the first time by Mr. Coxwell and yourself, and which (for the reason which you give of its having appeared to be *beneath*, as if from conflicting currents below you) could in no way have been owing to the cordage of the balloon. With us it also seemed to arise from conflicting currents, but overhead, above, and rather around than below us.

I remain, dear Mr. Glaisher,

Yours very truly,

A. S. HERSCHEL.

Collingwood, Hawkhurst,
May 31, 1869, 3 P.M.

DEAR MR. GLAISHER,—There was a repetition of the phenomenon of "sound in the upper air" this afternoon, here, at half-past 12 o'clock. A roaring noise was first heard by persons in and out of doors, who all went out to see what could be the cause of the

* I think that this must have been the sound of the militia artillery practising in the direction of Hastings.

thunder. It came very suddenly, with a tremendous gust of wind along the ground, which bent the tree branches, but did not break them, and the sky was covered with a perfect pall of black cloud which had spread over the sky and hidden the sun very suddenly. The wind fell very quickly, and the air returned to its first *perfectly calm* state (which it had before, and still has since the storm) in a very short time; but the thunder-like noise continued for about three minutes without any interruption. To some it seemed to be a "sewing-machine at work" in the room overhead. Others thought that it was the roaring of the wind, and were surprised, on going to the window, to see the leaves perfectly motionless, while the sound which seemed to come from the clouds continued. Five or ten minutes after the sound ceased, there fell a *drenching* shower of rain, quite perpendicular, which converted the roads into waterpools wherever water could lie, and there was no wind. Being in an underground part of the house I heard the sound, and at first thought that it was thunder, as it at first broke out rather suddenly, but it continued to die away so gradually that I thought it must be some articles of furniture being wheeled along or moved in the house, and I paid no attention to it until its real character was, just now, described to me. About ten minutes after the sound, when I went upstairs, rain was still falling, there was no wind, the air was rather cold, and the clouds in the sky appeared to be of too transitory a character to be connected with a thunderstorm, to which I would no longer have attributed the sound, if those who observed it more particularly had not noticed that it appeared to issue *like* thunder, directly from the clouds. My impression is that the noise was made by a water-spout, or small whirlwind in the upper air, of which the only effects that reached the ground were the sound, the slight puff of wind, and the shower.

I have now sent you (at different times) four accounts of similar cases of sound like long-continued thunder in the air, and I believe that they are all thoroughly authentic cases of "sound in the upper air when the lower air is still," and that the best explanation of them is that which occurred to you during your eleventh balloon ascent, that they are produced by conflicting air-currents in the upper regions of the atmosphere.

I remain, dear Mr. Glaisher,

Yours very sincerely,

A. S. HERSHEL.



ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. TAYLOR and FRANCIS, Red Lion Court, Fleet Street. London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line. .	0	0	6	Bills, half-sheet and less. .	1	10	0
Half a page	0	17	6	„ whole sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

SESSION 1869-70,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1869. November	17	1870. March	16
1870. January	19	„ April	20
„ February	16	„ June	15

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Hours of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

"Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. BELVILLE'S Books."—*Athenæum*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, F.R.S., SECRETARY.

1870, JAN. 19.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
VI. On the Temperature and Humidity of the Air at the Heights of 20 feet and 50 feet above the Ground, in comparison with the Temperature and Humidity of the Air at the Height of 4 feet. —J. Glaisher, F.R.S.	29
VII. Rainfall at Jerusalem during the Rainy Season of 1868-69.— Thomas Chaplin, M.D.	50
VIII. <i>Omnia Observantia</i>	51

Correspondence, &c.:—

The South-African Exploring Party	52
To find the Error in Reading the Cistern-Barometer if not hung truly vertical.—The Rev. W. Previtt, M.A., F.R.S. (in correction of paper No. II. Proc. 45, Nov. 1869)	53
November Meteors, 1869, in a letter to the Editor	54

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, February.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.]

1870, JANUARY 19.

[No. 46.]

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Crompton, Rev. Joseph, M.A., *Bracondale, Norwich* ;
Fox, Cornelius B., M.D., M.R.C.P., F.O.S., *South Cliff, Scarborough* ;
Sykes, Edwin John, A.P.S., *Devonshire Hospital, Buxton* ;
were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society
were read.

VI. *On the Temperature and Humidity of the Air at the Heights
of 22 feet and 50 feet above the Ground, in comparison with the
Temperature and Humidity of the Air at the Height of 4 feet.*
By JAMES GLAISHER, F.R.S.

OUR knowledge of the temperature and humidity of the air near
the surface of the earth is almost entirely confined to within 4 or
5 feet above the earth. The theory that the temperature was
always lower at higher elevations was proved not to be at all
times true, and the theory of the decline of 1° of temperature in
every increase of 300 feet of elevation, was proved to be erroneous

in every balloon ascent I made; in some a decrease of 1° and more than 1° was experienced within 100 feet, and there is no doubt that, considering the quickness of motion when near the earth, the decline at such times would have been as large as 2° or 3° , or more, within the space of 100 feet.

In some of the ascents a difference of 10° was met with within 1000 feet, whilst in others but little or no difference was experienced even to heights exceeding 1000 feet.

Towards the end of my balloon experiments it was proved that the temperature near the earth varied greatly, and that it seemed to be different at the different hours of the day.

The great 'Captive Balloon,' recently located at Ashburnham Park, Chelsea, was well adapted to give most valuable information, and M. Giffard kindly placed it at my disposal for a series of experiments upon the temperature and humidity of the air.

This balloon could ascend to the height of 2000 feet on a calm day; its rate of ascension could be regulated at will; it could be kept stationary at any elevation, and experiments could be repeated several times in the day.

On two different days I ascended nine times on each day; there was a decrease of temperature with increase of elevation at every ascent, but different in amount at every hour, being less and less as the day advanced towards sunset.

The general results are shown in Table I.

TABLE I. Showing the amount of Decrease of Temperature per 100 feet of elevation, at different Hours of the Day, with a Clear Sky and a Cloudy Sky, as found by experiments with M. Giffard's 'Captive Balloon.'

Height above the ground.		Clear Sky.					
		10 ^h A.M. to 11 ^h A.M.	3 ^h P.M. to 4 ^h P.M.	4 ^h P.M. to 5 ^h P.M.	5 ^h P.M. to 6 ^h P.M.	6 ^h P.M. to 7 ^h P.M.	7 ^h P.M. (about.)
ft.	ft.	°	°	°	°	°	°
0	100	1'0	1'4	1'2	0'9	0'5	0'0
100	200	1'0	0'8	0'7	0'7	0'5	0'1
200	300	0'9	0'7	0'6	0'7	0'5	0'2
300	400	0'9	0'6	0'5	0'7	0'5	0'3
400	500	0'8	0'6	0'4	0'6	0'5	0'3
500	600	0'7	0'5	0'4	0'5	0'5	0'3
600	700	0'6	0'5	0'4	0'4	0'5	0'4
700	800	0'6	0'5	0'4	0'4	0'5	0'4
800	900	0'5	0'5	0'4	0'4	0'4	0'4
900	1000	0'5	0'5	0'4	0'4	0'4	0'4

TABLE I. (*continued.*)

Height above the ground.		Cloudy Sky.				
		3 ^h P.M. to 4 ^h P.M.	4 ^h P.M. to 5 ^h P.M.	5 ^h P.M. to 6 ^h P.M.	6 ^h P.M. to 7 ^h P.M.	7 ^h P.M. to 8 ^h P.M.
ft.	ft.					
0	100	0	1'2	0'8	0'6	0'5
100	200	0'9	0'7	0'6	0'6	0'5
200	300	0'9	0'6	0'6	0'6	0'5
300	400	0'7	0'5	0'6	0'5	0'5
400	500	0'5	0'4	0'5	0'5	0'5
500	600	0'5	0'4	0'5	0'5	0'5
600	700	0'4	0'4	0'5	0'5	0'5
700	800	0'4	0'4	0'5	0'5	0'5
800	900	0'4	0'4	0'4	0'5	0'5
900	1000	0'4	0'4	0'4	0'5	0'4

This series of experiments proved that, which was indicated in the several ascents with a free balloon, viz. that the change of temperature with increase of elevation has a diurnal range, the change being the greatest at about midday and the early afternoon hours, decreasing until about sunset, at which time, when the sky was free from clouds, there was little or no change of temperature up to the height of several hundred feet. I was not able to take any observations after sunset; but such observations were very greatly needed, as there seemed to be a very great probability that the temperature of the air at night must frequently increase with elevation when the sky is cloudless.

If the change of temperature within 100 feet of the earth, at times, is as large as several degrees, and, as in all experiments, the largest changes have taken place the nearest to the earth, there seemed to be a probability that, if observations were made to the height of 50 feet, the law both of diurnal and of seasonal change might be determined up to that elevation.

For several years, observations of the dry- and wet-bulb thermometers at the height of 22 feet have been made, but they have not yet been reduced or compared with the temperature and humidity of the air near the earth.

A second pair of dry- and wet-bulb thermometers was placed on the leads of the octagon room at the Royal Observatory, Greenwich, at the height above the ground of 50 feet in the shade; but as it was not so well protected as those near the ground, some fear was

entertained that the reflected heat from the leads might cause the readings to be too high by day, and that the radiation by night might unduly lower the readings.

They were placed in position on June 25, 1868, and read several times a day, till August 6, 1868, during the whole of the very hot

TABLE II. Showing the Temperature of

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	NOON.	1 P.M.	2 P.M.	3 P.M.
June 25.....	...	67.7	...	...	69.2	...	...	70.5
26.....	...	69.0	72.3	75.1	75.3	...	...	77.5
27.....	...	74.7	78.4	...	84.6	85.1	85.9	86.9
28.....	...	...	67.1	...	72.8	...	...	...
29.....	...	60.6	65.9	68.9	71.6	72.8	73.0	72.1
30.....	...	65.0	70.2	73.7	75.1	72.8	73.1	73.0
July 1.....	...	56.9	58.7	59.2	64.8	66.2	67.5	70.3
2.....	...	64.5	67.8	71.3	72.8	74.9	75.2	77.3
3.....	...	63.3	67.0	70.4	73.8	77.5	78.7	78.9
4.....	...	59.5	56.6	61.3	60.1	59.8	63.3	62.3
5.....	...	...	66.4	...	65.5	...	...	...
6.....	...	62.4	64.8	65.8	72.8	69.3	69.2	70.3
7.....	...	68.2	71.8	72.0	74.8	74.5	72.2	75.3
8.....	...	74.6	79.1	75.2	79.7	...	83.0	75.9
9.....	...	75.2	80.2	79.7	84.3	81.1	...	81.8
10.....	...	73.0	77.1	75.9	78.2	76.8	...	78.4
11.....	...	71.7	75.9	78.7	79.5	80.8	81.8	81.6
12.....	...	...	69.1	...	73.4	73.4	...	...
13.....	...	65.4	72.0	76.4	79.7	81.8	83.8	82.6
14.....	...	68.9	74.2	78.3	79.7	83.0	83.4	83.6
15.....	...	75.2	81.7	84.5	86.2	84.9	85.9	82.1
16.....	...	80.8	84.9	86.2	89.1	87.1	88.8	90.5
17.....	...	76.2	77.3	76.7	79.4	78.3	76.8	83.2
18.....	...	73.7	79.9	82.6	83.3	84.0	85.4	81.8
19.....	...	72.2	72.5	...	75.9	...	...	...
20.....	...	79.8	81.9	85.8	85.4	88.6	88.0	87.9
21.....	...	79.4	82.1	84.2	87.9	91.3	91.3	90.3
22.....	...	83.1	88.4	92.5	89.7	90.0	94.3	89.0
23.....	72.2	77.5	75.8	69.2	66.3	69.6	70.1	66.0
24.....	...	65.4	69.4	70.6	71.0	72.0	71.1	72.0
25.....	...	65.8	68.5	72.5	74.9	75.7	74.9	75.9
26.....	...	...	73.0	...	82.6	...	...	...
27.....	...	77.6	81.7	82.8	85.2	86.4	87.0	88.8
28.....	...	79.6	84.0	85.4	90.0	89.4	88.1	87.0
29.....	...	63.2	62.8	60.6	59.3	58.6	63.5	61.3
30.....	...	64.1	68.7	71.5	74.7	77.5	80.2	78.2
31.....	...	70.1	72.1	72.5	75.1	76.5	76.0	76.9
August 1.....	...	68.2	72.3	76.2	80.0	81.3	80.9	82.2
2.....	69.6	75.2	...	...	81.1	...	...	...
3.....	...	76.6	78.4	79.7	80.0	80.2	...	77.3
4.....	...	79.2	83.8	83.0	82.6	85.4	83.7	83.0
5.....	...	79.4	80.5	84.9	88.4	89.3	87.9	86.2
6.....	...	65.8	66.7	70.5	72.5	72.7	71.3	75.2

month of July of that year, and the observations were made mostly by W. C. Nash, F.M.S.

The following are the readings of the dry thermometer at 4 feet, read simultaneously with those at 22 feet and 50 feet above the ground.

the Air 4 feet above the ground.

Observation.								
4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
°	°	°	°	°	°	°	°	°
78°0	70°8	68°4	66°9	63°0	61°3	...	...	...
...	76°1	73°6	70°3	64°9	60°8	...	...	...
...	...	79°4	...	...	68°7	...	...	...
...	...	...	...	62°6	61°9	...	...	...
...	...	66°7	...	...	56°8	53°9	52°5	51°4
71°8	...	64°9	...	...	58°5	...	...	...
...	...	68°1	...	...	57°6	...	...	...
...	...	66°7	...	...	61°8	...	...	...
...	...	69°6	...	...	58°4	...	...	...
...	...	59°6	...	...	53°4	...	...	...
...	...	...	...	61°8	...	...	...	...
...	...	66°2	...	...	60°5	...	...	...
...	...	71°7	...	...	63°8	...	...	...
...	...	75°9	...	...	68°1	...	...	...
...	...	72°5	...	...	63°3	...	...	...
...	...	73°7	...	...	64°4	...	...	...
79°7	...	74°4	...	...	66°9	...	...	...
...	...	...	...	...	66°3	...	...	...
...	...	76°1	...	68°6	66°6	...	...	...
...	...	72°1	...	67°2	65°7	...	61°6	...
...	...	78°9	...	...	69°6	...	...	...
...	...	81°9	...	...	72°0	...	...	...
...	...	74°0	...	...	68°1	...	...	...
...	...	74°9	...	...	70°2	...	...	...
...	...	...	...	...	65°9	...	...	...
...	...	80°0	76°2	72°8	68°8	...	...	...
...	...	...	...	...	72°7	...	...	...
88°4	...	86°0	...	78°9	75°6	...	70°8	...
...	...	63°0	...	...	59°4	...	...	...
...	...	64°0	...	...	57°7	...	...	...
...	...	68°2	...	...	61°3	...	...	...
...	...	...	...	...	65°1	...	...	...
...	...	79°4	...	...	70°1	68°4	66°6	65°8
...	...	74°4	...	...	64°2	...	...	...
...	...	61°3	...	...	58°8	...	...	...
...	...	72°5	...	...	66°8	...	...	...
...	...	70°1	...	...	62°1	...	...	...
...	...	75°8	...	...	63°9	60°6	...	...
...	...	...	...	67°0	...	...	...	...
...	...	69°4	...	...	65°2	...	...	...
...	...	76°8	...	...	68°6	...	...	...
...	...	73°1	...	...	65°7	...	...	...
...	...	68°3	...	...	66°3	...	...	...

By taking the difference between the readings at 4 feet and

TABLE III. Showing the differences between the Temperature

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	Noon.	1 P.M.	2 P.M.	3 P.M.
June 25.....	0	0	0	0	0	0	0	0
26.....	...	+2.7	...	...	+0.7	...	...	+0.5
27.....	...	-0.9	+0.3	+2.9	+1.5	...	...	+1.5
28.....	...	+1.5	+2.0	...	+3.1	...	+2.4	+3.1
29.....	...	...	-1.7	...	+2.8	...	...	...
30.....	...	+1.6	+2.9	+2.9	+6.6	+2.8	+4.8	+1.7
July 1.....	...	+1.4	+5.7	+6.2	+5.5	+4.0	+3.1	+3.2
2.....	...	+0.4	+0.8	+0.9	+3.7	+0.2	+2.5	+3.8
3.....	...	+1.6	+1.8	+3.5	+3.0	+3.4	+1.2	+5.3
4.....	...	+1.8	0.0	+1.6	+3.0	+2.5	-0.1	+4.9
5.....	...	+0.2	+0.6	+1.8	+0.5	+0.3	+1.7	+0.3
6.....	...	...	+1.9	...	+0.7	...	...	...
7.....	...	+0.2	-0.8	-1.0	-0.2	-0.4	+1.2	+0.8
8.....	...	+1.4	+1.9	+0.1	+1.9	-4.4	-0.3	+2.0
9.....	...	+3.6	+3.6	-3.2	-0.3	...	+0.7	-2.2
10.....	...	+2.2	+1.7	+1.6	-0.2	+0.6	...	+0.7
11.....	...	+4.5	+4.6	+0.8	+4.2	+1.6	...	+0.8
12.....	...	+3.3	+2.9	+1.4	+1.4	+3.1	+2.1	...
13.....	...	...	+1.1	...	-0.5	-0.1	...	...
14.....	...	+0.3	+0.9	+2.3	+0.4	+3.9	+3.0	+2.5
15.....	...	+2.2	+1.2	+3.1	+3.7	+4.5	+1.9	+2.3
16.....	...	+1.2	+4.2	+1.8	+0.2	-2.2	-2.4	-1.8
17.....	...	+1.0	+2.0	+0.5	+1.6	-1.9	+1.4	+3.5
18.....	...	+2.2	+0.8	+0.2	+0.6	+2.3	+0.5	+2.3
19.....	...	+0.1	+0.7	+1.3	+2.2	+1.7	+4.4	+1.1
20.....	...	+1.2	+1.0	...	+0.9	...	...	...
21.....	...	+2.8	+2.7	+5.8	+3.1	+3.6	+2.5	+3.7
22.....	...	-1.3	-1.2	-1.2	+1.2	+3.1	+1.8	+1.3
23.....	...	-1.4	+1.3	+2.7	-1.6	-0.6	+0.3	-3.0
24.....	+1.1	+2.9	+1.0	+1.0	+0.5	+1.6	+1.3	+0.5
25.....	...	+2.7	+5.2	+3.8	+4.3	+3.3	+2.3	+3.2
26.....	...	-0.2	+2.4	+3.7	+5.4	+4.1	+1.9	+3.9
27.....	...	...	+0.5	...	+5.5	...	...	...
28.....	...	+2.3	+3.7	-0.2	+0.9	+1.9	+2.1	+2.1
29.....	...	+2.6	+1.0	+1.2	+4.8	+3.9	+3.4	+4.0
30.....	...	+1.7	+1.8	+1.4	+0.4	+0.8	+2.4	+0.3
31.....	...	+1.4	+1.9	+1.0	+0.6	+1.5	+3.3	+1.0
August 1.....	...	+1.1	+2.6	+1.0	+2.6	+1.0	-0.2	+0.9
2.....	+0.6	+2.7	+0.8	+1.2	+1.7	+1.3	+0.3	+1.0
3.....	...	+2.1	...	...	+0.9	...	...	...
4.....	...	+2.0	+2.6	+3.1	+1.8	+4.7	...	-0.8
5.....	...	+2.3	+2.5	+1.2	-0.1	+2.1	...	+2.0
6.....	...	+2.2	+2.2	+0.2	+1.9	+2.3	-1.6	+2.5
7.....	...	-0.2	-0.3	-0.8	+0.2	+0.5	-1.7	+2.4

NOTE.—The sign plus (+) signifies that the temperature at the lower station temperature.

those taken at the same time at 22 feet, Table III. was formed.

of the Air at 4 feet and 22 feet above the ground.

Observation.								
4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
0	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...
-0.3	+0.5	-1.0	-0.9	-0.2	-2.7	...	...	...
...	+0.8	-0.2	-1.0	-0.2	-1.2	...	...	...
...	...	-0.6	...	...	-1.8	...	...	...
...	...	...	...	-0.1	-0.4	...	...	...
...	...	-0.8	...	...	-0.2	-1.1	-1.8	-2.6
+3.0	...	+0.8	...	...	+0.4	...	...	...
...	...	-0.3	...	...	-0.4	...	...	...
...	...	-0.8	...	...	+1.2	...	...	...
...	...	+1.5	...	...	+0.5	...	...	...
...	...	+0.4	...	...	+0.4	...	...	...
...	...	...	...	-1.3	...	...	...	...
...	...	+0.2	...	...	-0.3	...	...	...
...	...	-1.9	...	...	-2.3	...	...	...
...	...	-1.1	...	...	-2.7	...	...	...
...	...	-1.3	...	...	-0.8	...	...	...
...	...	-0.3	...	...	0.0	...	...	...
+2.0	...	+1.1	...	...	0.0	...	...	...
...	...	...	...	...	-0.2	...	...	...
...	...	+0.1	...	-0.9	-1.0	...	...	...
...	...	-0.6	...	0.0	-0.4	...	-1.2	...
...	...	-1.4	...	...	-1.8	...	...	...
...	...	-0.1	...	...	+0.9	...	...	...
...	...	-0.8	...	...	-0.7	...	...	...
...	...	-0.2	...	...	-0.8	...	...	...
...	...	...	...	...	-3.0	...	...	...
...	...	-1.0	-1.2	-1.3	-1.3	...	...	...
...	...	...	...	...	-1.8	...	...	...
-0.7	...	-1.5	...	-1.1	-0.6	...	-1.0	...
...	...	...	...	...	-0.3	...	...	...
...	...	-0.8	...	...	-0.8	...	...	...
...	...	+0.7	...	...	-0.3	...	...	...
...	...	...	...	...	+1.1	...	...	...
...	...	0.0	...	...	-0.3	-1.4	-0.8	-0.6
...	...	+0.5	...	...	-0.8	...	...	...
...	...	+0.6	...	...	-1.3	...	...	...
...	...	-1.1	...	...	+0.8	...	...	...
...	...	-0.2	...	...	-1.7	...	...	...
...	...	-1.6	...	...	-1.9	-3.4	...	...
...	...	...	...	-0.3	...	...	...	...
...	...	-0.4	...	...	+0.2	...	...	...
...	...	-1.2	...	...	-0.2	...	...	...
...	...	-1.7	...	...	-0.5	...	...	...
...	...	+1.1	...	...	-0.3	...	...	...

was higher than at the upper station, and the sign minus (—) that it was of lower

Glancing at the numbers in this Table, we at once see the great preponderance of + signs during the day hours (denoting higher temperature at the lower station), and of — signs during the night hours (implying higher temperature at the upper station).

At 7^h A.M. only two observations were taken; both have + signs.

At 9^h A.M. there were thirty-nine observations; of these, thirty-four have + signs and five have — signs; the largest number with the + sign is 4°5, and the largest with — sign is 1°4.

At 10^h A.M. there were forty observations, and of these, thirty-six have + signs, and four —. The largest number with a + is 5°7, and with a — is 1°7.

At 11^h A.M. thirty-five observations were made; of these, thirty have + signs and five — signs. The largest number with a + sign is 6°2, and the largest number with a — sign is 3°2.

At NOON the observations were forty-three in number, the + signs exceeding the — by thirty-one, the respective numbers being thirty-seven and six. The largest number with a + sign is 6°6, and with a — sign is 1°6.

At 1^h P.M. there were thirty-four observations, and of these, twenty-eight have + signs, and six — signs. The largest numbers with the respective signs exceeded 4°.

At 2^h P.M. the observations were thirty-one in number; of these, twenty-five have + signs, and six — signs. The largest number with a + sign is 4°8, and with a — sign 2°4.

At 3^h P.M. thirty-six observations were made, the + signs (thirty-two in number) exceeding the — signs by twenty-eight. The largest number with a + sign is 5°3, and 3° is the largest with a — sign.

At 4^h P.M. and 5^h P.M. only five observations were taken; all have a + sign.

At 6^h P.M. thirty-five observations were taken; of these, ten only have a + sign, whilst the remaining twenty-five have a — sign. The largest number with a + sign is 1°·5, and the largest with a — sign is 1°·9.

At 7^h P.M. and 8^h P.M. twelve observations were taken, all with a — sign.

At 9^h P.M., of forty-one observations recorded, eight have the + sign, the remainder have the — sign. The largest number with a + sign is 1°·2, and with a — sign is 3°.

At 10^h and 11^h P.M., and at MIDNIGHT, nine observations were taken, and all have — signs.

Thus, at times, the temperature of the air at 4 feet above the ground during the midday hours has been as much as 4°, 5°, and 6° higher than at the height of 22 feet, and at night has been as much as 2° and 3° colder than at the higher elevation.

By taking the means of the numbers in Tables III. and IV., we find that the mean temperature of the air was,

	At 22 feet.	At 50 feet.	
At 9 A.M.	1°·5 lower,	1°·9 lower,	} than at 4 feet.
10 "	1°·8 "	2°·7 "	
11 "	1°·6 "	3°·2 "	
Noon	1°·9 "	3°·9 "	
1 P.M.	1°·7 "	3°·6 "	
2 "	1°·4 "	3°·5 "	
3 "	1°·7 "	3°·2 "	
6 "	0°·4 higher,	0°·4 higher,	
9 "	0°·6 "	1°·3 "	
10 "	2°·0 "	3°·4 "	
11 "	1°·2 "	2°·7 "	
Midnight.....	1°·6 "	3°·3 "	

By taking the difference between the readings at the heights of 4 feet and 50 feet above the ground, the next Table was formed.

TABLE IV. Showing the differences between the Temperature of

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	Noon.	1 P.M.	2 P.M.	3 P.M.
June 26.....	°	°	°	°	°	°	°	+1'3
27.....	...	+3'7	+3'6	...	+6'3	+5'9	+4'9	+5'4
28.....	...	...	-0'9	...	+4'3	...	...	...
29.....	...	+1'5	+4'9	+4'6	+6'9	+6'9	+4'2	+4'5
30.....	...	+3'0	+6'0	+5'7	+6'1	+5'8	+5'7	+3'7
July 1.....	...	+0'9	+1'2	+1'2	+4'1	+2'6	+0'8	+3'3
2.....	...	+0'1	+4'8	+6'3	+6'5	+5'9	+3'8	+6'6
3.....	...	+2'1	+1'4	+3'9	+4'8	+4'9	+2'8	+3'9
4.....	...	+1'5	+1'1	+0'7	+0'1	+0'2	+2'1	+0'7
5.....	...	...	+2'1	...	+1'2	...	...	...
6.....	...	+1'7	+0'3	+0'7	+3'8	+1'6	+2'4	+2'9
7.....	...	+2'5	+3'5	+2'8	+3'8	-3'3	-0'3	+3'1
8.....	...	+5'1	+5'1	+0'4	+1'7	...	+3'9	-3'1
9.....	...	+1'3	+2'9	+2'4	+5'3	+2'6	...	+3'5
10.....	...	+3'3	...	+3'7	+4'3	+2'0	...	+2'1
11.....	...	+3'4	+4'5	+3'9	+4'2	+4'0	+4'5	...
12.....	...	...	+1'2	...	+0'2	-0'8	...	...
13.....	...	-0'4	+2'1	+2'6	+2'6	+3'7	+4'3	+3'3
14.....	...	...	+3'1	+2'8	+3'7	+5'2	+3'6	+4'3
15.....	...	+1'7	+4'7	+4'3	+2'7	+0'5	+1'0	-0'4
16.....	...	+2'3	+2'9	+2'7	+5'5	+2'8	+5'6	+6'0
17.....	...	+3'7	+3'3	+0'9	+3'4	+2'8	+1'8	+5'3
18.....	...	+1'5	+3'2	+4'8	+4'5	+5'1	+5'7	+1'1
19.....	...	...	+1'6	...	+1'9	...	...	...
20.....	...	+4'3	+4'9	+6'5	+6'5	+8'1	+3'6	+4'9
21.....	...	-1'1	+0'8	+1'1	+2'9	+7'3	+4'1	+3'5
22.....	...	-0'4	+1'9	+5'3	+2'4	-0'2	+4'2	-0'5
23.....	+1'1	+3'2	+2'8	+1'5	+0'3	+0'9	+3'3	+0'8
24.....	...	+2'9	+3'4	+4'9	+5'1	+4'5	+4'4	+4'4
25.....	...	-0'9	+2'6	+5'1	+6'9	+5'7	+3'3	+5'3
26.....	...	...	+1'2	...	+5'0	...	...	...
27.....	...	+2'9	+5'2	+3'8	+4'4	+4'5	+4'1	+6'1
28.....	...	+0'9	+2'9	+3'6	+8'2	+6'1	+5'8	+5'2
29.....	...	+2'2	+2'5	+1'6	+0'3	+0'1	+2'2	+0'7
30.....	...	+1'1	+2'7	+3'0	+3'6	+5'2	+6'7	+4'2
August 1.....	...	+1'9	+2'7	+3'2	+3'9	+4'0	+1'4	+3'4
2.....	+0'1	+1'7	...	...	+3'1	...	...	...
3.....	...	+2'4	+3'1	+3'7	+5'0	+3'9	...	+1'8
4.....	...	+2'3	+4'0	+3'4	+3'2	+5'8	...	+3'7
5.....	...	+3'4	+2'8	+4'1	+5'4	+5'6	+4'3	+4'6
6.....	...	+0'1	+0'4	-0'3	...	+1'7	...	...

NOTE.—The sign plus (+) signifies that the temperature of the air was higher

the Air at 4 feet and 50 feet above the ground.

Observation.

4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
0	0	0	0	0	0	0	0	0
+0.2	+0.6	-0.6	-1.1	-1.1	-2.3	...	...	...
...	...	-1.6	...	...	-0.3	...	...	...
...	...	...	...	-0.4	-0.1	...	...	...
...	...	-0.3	...	...	-1.0	-2.1	-3.5	-4.5
+4.1	...	+0.8	...	...	-0.5	...	...	...
...	...	+0.1	...	...	-1.7	...	...	...
...	...	-0.3	...	...	+1.8	...	...	...
...	...	+0.9	...	...	+0.2	...	...	...
...	...	+0.6	...	...	+0.4	...	...	...
...	...	...	...	-2.5	...	...	...	...
...	...	+0.1	...	...	-3.4	...	...	...
...	...	-2.0	...	...	-5.1	...	...	...
...	...	-1.3	...	...	-3.7	...	...	...
...	...	-0.7	...	...	-1.9	...	...	...
...	...	+0.6	...	...	-1.1	...	...	...
+2.7	...	+0.4	...	...	-0.7	...	...	...
...	...	...	...	...	...	...	...	...
...	...	-0.4	...	-1.6	-1.9	...	...	...
...	...	+0.8	...	-0.7	-1.1	...	-1.9	...
...	...	-1.7	...	...	-3.4	...	...	...
...	...	-1.4	...	...	+0.5	...	...	...
...	...	0.0	...	...	+0.1	...	...	...
...	...	-1.0	...	...	-1.4	...	...	...
...	...	...	...	...	-3.1	...	...	...
...	...	-1.8	-2.5	-2.7	-3.2	...	...	...
...	...	...	...	...	-3.4	...	...	...
+0.5	...	-1.1	...	-1.7	-1.4	...	-2.4	...
...	...	+0.9	...	...	-0.7	...	...	...
...	...	+0.2	...	...	-1.7	...	...	...
...	...	+0.7	...	...	-0.9	...	...	...
...	...	...	...	...	-0.9	...	...	...
...	...	0.0	...	...	-2.7	-2.8	-3.0	-2.1
...	...	+0.6	...	...	-1.2	...	...	...
...	...	-0.1	...	...	-2.6	...	...	...
...	...	-1.4	...	...	+0.7	...	...	...
...	...	-1.9	...	...	-3.4	...	...	...
...	...	-1.3	...	...	-3.0	-5.4	...	...
...	...	...	...	-1.0	...	...	...	...
...	...	-0.6	...	...	-0.6	...	...	...
...	...	-0.4	...	...	+0.4	...	...	...
...	...	-0.6	...	...	-0.5	...	...	...
...	...	...	...	...	+0.1	...	...	...
...	...	...	...	...	...	...	...	...

at the lower station than at the upper, and the sign minus (-) that it was lower.

Looking over the signs in this Table, the same preponderance of + signs during the day and of — signs during the night are shown as in Table III., but the quantities are generally larger.

At 7^h A.M. two observations were taken, and both have + signs.

At 9^h A.M. thirty-one observations were taken, of which thirty-one have plus signs, and four have — signs. The largest number with the + sign is 5°·1, and with the — sign is 1°·1.

At 10^h A.M. thirty-nine observations were taken, and all but one have the + sign. The largest number is 6°.

At 11^h A.M. thirty-four observations were taken; one reading only is affected with the — sign. The largest number with a + sign is 6°·5.

At NOON forty observations were taken, all with the sign +. The largest number exceeds 8°.

At 1^h P.M. thirty-five observations were made; the largest number with a + sign is 8°·1, and the largest number with a — sign (of which there are three) is 3°·3.

At 2^h P.M., out of thirty observations, one only is affected with the sign —. The largest number with + sign is 6°·7.

At 3^h P.M. the observations are thirty-four in number, of which thirty-one have the sign +. The largest number with that sign is 6°·6.

At 4^h P.M. and 5^h P.M., five observations were taken, all have + signs.

At 6^h P.M., out of thirty-four observations, twelve have + signs, the remaining twenty-two have — signs.

At 7^h P.M. and 8^h P.M. ten observations were made, and all have a — sign.

At 9^h P.M. thirty-nine observations were taken; the number with a + sign is eight, and with a — sign is thirty-one. The largest number with a + sign is 1°·8, and with a — sign 5°·1.

At 10^h and 11^h P.M., and at MIDNIGHT, nine observations were taken, all of which bear the sign —.

Thus it appears that during the day hours the temperature of the air at the height of 4 feet above the ground, has been at times 7° and 8° of higher temperature than at 50 feet high, and that at night it has been as much as 3° , 4° , and 5° of lower temperature than at the higher elevation. If the thermometers were not sufficiently protected from the effects of the heated roof by day, or the cooled roof by night, the readings would have been higher by day and lower by night, and would have caused the differences with + signs by day to be less, and those with - signs by night to be less also; but I believe the protection was sufficient.

By taking the means of the readings at each elevation during the whole period, the mean temperature was,

	At 4 feet.	At 22 feet.	At 50 feet.
At 9 A.M.	71.0	69.5	69.1
10 "	73.7	71.9	71.0
11 "	75.8	74.2	72.6
Noon	77.4	75.5	73.5
1 P.M.	78.5	76.8	74.9
2 "	79.2	77.8	75.7
3 "	78.7	77.0	75.5
6 "	72.0	72.4	72.4
9 "	64.5	65.1	65.8
10 "	61.9	63.9	65.3
11 "	60.3	61.5	63.0
Midnight.....	59.6	61.2	62.9

By laying these numbers down on a diagram (see Plate I.) we see the temperatures at the different elevations during the hours from 7 A.M. to midnight, and that, between the hours of 5 and 6 P.M., the temperatures at the different elevations were of the same value; and if the lines forming the ascending branch be continued backwards, they would cross each other between the hours of 5 and 6 A.M.

Thus it would seem that, during the period of these observations, for the twelve hours from $5\frac{1}{2}$ A.M. to $5\frac{1}{2}$ P.M. the temperature at 4 feet high was higher than at the higher elevations, and that during the remaining twelve hours it was lower than at the higher elevations.

I now proceed to discuss the humidity of the air. The following Table contains the degree of humidity at the height of 4 feet.

TABLE V. Degree of Humidity

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	Noon.	1 P.M.	2 P.M.	3 P.M.
June 25.....	...	60	...	...	57	...	...	59
26.....	...	53	50	49	45	...	...	43
27.....	...	53	47	...	39	35	33	35
28.....	...	...	59	...	50	...	...	...
29.....	...	64	53	51	47	46	46	48
30.....	...	62	53	47	50	53	51	55
July 1.....	...	83	74	70	61	61	57	53
2.....	...	67	61	57	55	53	51	47
3.....	...	75	68	59	54	43	40	40
4.....	...	78	97	72	68	71	60	59
5.....	...	...	52	...	54	...	...	...
6.....	...	69	65	60	51	51	52	51
7.....	...	59	53	51	46	55	50	48
8.....	...	56	50	56	50	...	41	50
9.....	...	60	52	48	41	39	...	38
10.....	...	58	51	51	46	46	...	41
11.....	...	60	53	48	48	43	42	41
12.....	...	...	73	...	67	70	...	...
13.....	...	80	65	59	53	44	40	38
14.....	...	60	54	47	42	40	39	43
15.....	...	59	50	47	39	40	42	40
16.....	...	56	47	44	40	41	40	38
17.....	...	64	59	61	55	57	59	46
18.....	...	63	52	49	40	43	39	33
19.....	...	64	60	...	50	...	...	...
20.....	...	41	37	38	33	31	30	30
21.....	...	55	53	49	43	40	40	40
22.....	...	52	40	36	32	32	30	31
23.....	61	53	59	71	77	64	63	69
24.....	...	50	46	46	45	44	45	44
25.....	...	59	53	49	44	40	44	43
26.....	...	...	61	...	40	...	...	...
27.....	...	58	46	42	40	36	38	36
28.....	...	54	46	38	39	37	35	38
29.....	...	66	68	72	82	89	74	77
30.....	...	76	63	54	53	49	46	47
31.....	...	56	53	50	46	41	39	37
August 1.....	...	58	53	46	44	39	37	34
2.....	53	48	...	...	43	...	...	...
3.....	...	65	55	54	55	53	...	53
4.....	...	53	47	44	38	39	36	35
5.....	...	55	53	44	39	38	37	39
6.....	...	96	95	84	75	77	65	67

4 feet from the ground.

Observation.								
4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
...	62	66	68	78	82	...	...	...
42	44	50	65	75	86	...	...	...
...	...	38	...	...	50	...	...	...
...	...	...	...	69	71	...	...	...
...	...	62	...	...	85	94	98	99
56	...	67	...	...	78	...	...	...
...	...	58	...	...	83	...	...	...
...	...	70	...	...	77	...	...	...
...	...	57	...	...	84	...	...	...
...	...	60	...	...	71	...	...	...
...	...	...	...	70	...	...	...	...
...	...	58	...	...	70	...	...	...
...	...	53	...	...	63	...	...	...
...	...	47	...	...	66	...	...	...
...	...	43	...	...	73	...	...	...
...	...	51	...	...	66	...	...	...
42	...	48	...	...	65	...	...	...
...	...	...	...	...	79	...	...	...
...	...	50	...	63	66	...	...	...
...	...	65	...	75	79	...	95	(96)
...	...	39	...	...	72	...	...	...
...	...	46	...	...	67	...	...	...
...	...	53	...	...	59	...	...	...
...	...	51	...	...	73	...	...	...
...	...	...	...	...	56	...	...	...
...	...	40	47	52	57	...	...	...
...	...	...	...	...	69	...	...	...
33	...	36	...	45	50	51	61	...
...	...	68	...	...	70	...	...	...
...	...	58	...	...	69	...	...	...
...	...	60	...	...	77	...	...	...
...	...	...	...	...	73	...	...	...
...	...	54	...	...	65	66	73	72
...	...	60	...	...	76	...	...	...
...	...	81	...	...	90	...	...	...
...	...	49	...	...	74	...	...	...
...	...	45	...	...	57	...	...	...
...	...	44	...	...	67	76	...	...
...	...	...	...	78	...	...	...	...
...	...	72	...	...	87	...	...	...
...	...	42	...	...	60	...	...	...
...	...	59	...	...	78	...	...	...
...	...	85	...	...	99	...	...	...

By taking the differences between the degrees of humidity at deduced from observations taken simultaneously at 22 feet above

TABLE VI. Differences between the Degree of Humidity

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	Noon.	1 P.M.	2 P.M.	3 P.M.
June 26.....	...	...	...	...	...	...	...	+ 3
27.....	...	+ 1	+ 2	...	+ 3	...	0	- 2
28.....	...	...	+ 5	...	- 2	...	...	...
29.....	...	- 2	- 3	- 5	- 7	- 6	- 5	- 1
30.....	...	- 4	- 7	- 9	- 7	- 8	- 6	- 4
July 1.....	...	+ 1	+ 1	- 2	- 6	+ 1	- 3	- 7
2.....	...	- 5	- 3	- 4	- 3	- 4	- 3	- 4
3.....	...	- 2	- 1	- 3	- 4	- 6	- 4	- 6
4.....	...	0	+ 8	- 3	- 1	- 1	+ 3	- 1
5.....	...	...	- 2	...	+ 4	...	...	...
6.....	...	- 2	+ 1	- 1	+ 5	- 1	+ 5	+ 1
7.....	...	- 1	+ 3	+ 4	+ 1	+ 8	+ 2	+ 3
8.....	...	- 3	0	+ 9	+ 9	...	+ 1	+ 5
9.....	...	- 4	- 2	- 1	- 1	- 4	...	- 2
10.....	...	- 6	- 7	- 3	- 9	- 6	...	- 8
11.....	...	- 8	- 9	- 7	- 5	- 9	- 8	...
12.....	...	...	0	...	+ 3	+ 4	...	...
13.....	...	+ 4	- 3	+ 2	0	- 1	0	0
14.....	...	- 1	+ 5	- 1	- 2	- 1	+ 1	- 1
15.....	...	- 1	- 4	+ 5	0	+ 2	+ 4	0
16.....	...	- 1	- 4	+ 1	- 1	- 4	+ 2	+ 1
17.....	...	- 4	- 5	+ 5	- 1	- 6	0	- 2
18.....	...	+ 4	- 3	+ 8	0	0	- 3	- 13
19.....	...	- 5	+ 1	...	- 1	...	...	...
20.....	...	- 5	- 3	- 1	- 1	- 3	- 2	- 4
21.....	...	- 2	0	- 2	- 2	- 4	0	- 1
22.....	...	- 1	- 3	- 3	- 1	- 1	- 2	- 1
23.....	- 4	- 7	- 7	- 6	- 4	- 5	- 1	- 6
24.....	...	- 7	- 9	- 4	- 6	- 4	- 4	- 11
25.....	...	+ 5	- 7	- 7	- 7	- 7	- 1	- 7
26.....	...	...	0	...	- 10	...	...	...
27.....	...	- 2	- 8	- 4	- 4	- 6	- 5	- 4
28.....	...	- 8	- 8	- 7	- 7	- 10	- 9	- 10
29.....	...	- 6	- 6	- 5	0	- 2	- 1	- 1
30.....	...	0	- 2	- 5	- 1	- 5	- 5	- 6
31.....	...	- 5	- 9	- 3	- 5	- 8	- 7	- 6
August 1.....	...	- 8	- 4	- 3	- 3	- 3	- 4	- 5
2.....	- 2	- 8	...	...	- 7	...	...	...
3.....	...	- 3	- 10	- 13	- 4	- 11	...	- 6
4.....	...	- 8	- 6	+ 3	- 1	+ 3	...	- 3
5.....	...	- 3	- 3	0	+ 2	0	+ 1	- 5
6.....	...	0	- 1	+ 2	0	- 3	- 4	- 4

NOTE.—The sign plus (+) signifies that the degree of humidity was greater at

4 feet above the ground (as shown in the above Table), and those the ground, Table VI. was formed.

at 4 feet and 22 feet above the ground.

Observation.								
4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
+ 3	+ 2	+ 4	+ 5	+ 1	+ 5	...	...	...
...	...	+ 3	...	...	+ 4	...	...	...
...	...	...	...	+ 2	0	...	...	...
...	...	0	...	...	...	+ 5	+ 10	+ 8
- 4	...	- 3	...	...	0	...	...	...
...	...	0	...	...	+ 2	...	...	...
...	...	+ 3	...	...	- 2	...	...	...
...	...	- 6	...	...	- 1	...	...	...
...	...	- 2	...	...	- 4	...	...	...
...	...	...	...	+ 8	...	...	...	...
...	...	+ 2	...	...	- 2	...	...	...
...	...	+ 7	...	...	+ 2	...	...	...
...	...	+ 2	...	...	+ 6	...	...	...
...	...	- 4	...	...	+ 5	...	...	...
...	...	- 4	...	...	- 4	...	...	...
- 2	...	- 2	...	...	- 2	...	...	...
...	...	...	...	...	- 7	...	...	...
...	...	+ 3	...	+ 4	+ 4	...	...	...
...	...	- 1	...	- 2	+ 1	...	+ 1	...
...	...	+ 2	...	...	+ 1	...	...	...
...	...	0	...	...	- 1	...	...	...
...	...	- 1	...	...	+ 4	...	...	...
...	...	+ 2	...	...	+ 1	...	...	...
...	...	...	...	...	+ 8	...	...	...
...	...	+ 1	+ 1	+ 1	+ 6	...	...	...
0	...	- 1	...	0	- 1	...	- 1	...
...	...	- 5	...	...	- 2	...	...	...
...	...	+ 2	...	...	+ 2	...	...	...
...	...	...	...	...	- 7	...	...	...
...	...	...	...	...	- 2	...	...	...
...	...	- 1	...	...	- 2	0	0	- 3
...	...	- 7	...	...	- 4	...	...	...
...	...	- 2	...	...	+ 7	...	...	...
...	...	+ 2	...	...	- 4	...	...	...
...	...	- 2	...	...	- 1	...	...	...
...	...	- 5	...	...	+ 2	+ 9	...	...
...	...	...	...	- 5	- 6	...	...	...
...	...	- 8	...	...	...	...	...	...
...	...	+ 2	...	...	+ 1	...	...	...
...	...	+ 3	...	...	+ 1	...	...	...
...	...	- 5	...	...	+ 6	...	...	...

the lower station, and the sign minus (—) that it was less.

Treating this Table in a similar manner as Tables III. and IV., we find that

At 7^h A.M. only two observations were made, and both have a — sign.

At 9^h A.M. thirty-seven observations were taken, of which five have a + sign, and thirty-two a — sign. The largest number bearing a + sign is 5, and a — sign is 8.

At 10^h A.M. forty observations were made, eight have a + sign, and thirty-two a — sign. The largest number with the + sign is 8, and the largest number with a — sign is 10.

At 11^h A.M. thirty-four observations are recorded, of which nine have the + sign, and twenty-five the — sign. The largest number with a + sign is 9, and with a — sign is 13.

At NOON forty-one observations were taken; seven have the + sign, and thirty-four the — sign. The largest number with a + sign is 9, and with a — sign is 10.

At 1^h P.M. thirty-four observations were made, of which five only have the + sign, and the remaining twenty-nine have the — sign. The largest number with a + sign is 8, and with a — sign is 11.

At 2^h P.M. thirty-one observations were made, of which eight have the + sign, and twenty-three the — sign. The largest number with + sign is 5, and with a — sign is 9.

At 3^h P.M. thirty-five observations were recorded, of which five have the + sign and thirty the — sign. The largest number with a + sign is 5, and with a — sign is 13.

At 6^h P.M. there appear fourteen + signs, and twenty — signs. The largest number with the + sign is 7, and with the — sign is 8.

At 9^h P.M. forty observations were made, and of these the number with the + sign is nineteen; after 9^h P.M. there were but few experiments, they generally have the sign +.

By taking the differences between the degrees of humidity at 4 feet and 50 feet, the next Table (VII.) was formed (see pp. 48, 49).

Comparing the numbers in this Table with those in Table VI., it will be seen that during the day-hours where the sign + appears in one it appears in the other, and that where the sign - appears in the former it also appears in the latter. By comparing the numbers together they are generally larger in Table VII. than in Table VI.

By taking the means of the numbers in Table VI. and VII., we find that the mean degree of humidity was

	At 22 feet.	At 50 feet.	
At 9 A.M.	3 greater,	4 greater,	
10 "	3 "	5 "	} than at 4 feet.
11 "	2 "	4 "	
Noon	2 "	5 "	
1 P.M.	3 "	5 "	
2 "	2 "	6 "	
3 "	3 "	5 "	
6 "	1 "	1 "	
9 "	1 less,	1 less,	
10 "	1 "	2 "	
11 "	2 "	4 "	
Midnight.....	2 "	6 "	

By taking the means of the numbers in Table V. and the means of the corresponding numbers for the heights of 22 feet and 50 feet, the mean degree of humidity was

	At 4 feet.	At 22 feet.	At 50 feet.
At 9 A.M.	62	65	66
10 "	57	60	62
11 "	53	55	57
Noon	49	51	54
1 P.M.	47	50	52
2 "	45	47	51
3 "	45	48	50
6 "	55	56	56
9 "	72	71	71
10 "	77	76	75
11 "	82	80	78
Midnight.....	85	83	79

TABLE VII. Degree of Humidity at 50 feet above

1868. Day.	Times of							
	7 A.M.	9 A.M.	10 A.M.	11 A.M.	Noon.	1 P.M.	2 P.M.	3 P.M.
June 26.....	...	...	...	...	...	...	...	0
27.....	...	- 1	+ 1	...	- 4	- 2	- 3	- 3
28.....	...	...	+ 3	...	- 4	...	...	...
29.....	...	- 3	- 9	- 8	-10	-10	- 6	- 6
30.....	...	- 9	-13	-13	-11	-14	-15	-11
July 1.....	...	- 4	- 6	- 6	-10	- 6	- 8	- 8
2.....	...	-12	- 8	- 6	-16	-13	- 5	- 4
3.....	...	- 7	-11	-13	- 4	- 6	- 3	- 6
4.....	...	0	- 2	+ 4	- 1	0	- 6	- 7
5.....	...	...	+ 4	...	+ 4	...	...	...
6.....	...	- 3	0	+ 5	+ 6	+ 3	0	+ 1
7.....	...	+ 2	0	0	- 1	+10	+ 2	+ 1
8.....	...	- 4	- 4	+ 8	+ 6	...	- 2	+ 5
9.....	...	0	- 3	- 2	- 4	- 6	...	- 4
10.....	...	- 7	...	- 9	-11	- 5	...	- 9
11.....	...	-12	-14	-12	-10	-11	-12	...
12.....	...	...	- 2	...	+ 3	+ 6	...	...
13.....	...	+ 5	+ 1	- 1	+ 1	- 1	- 1	- 2
14.....	...	...	- 3	- 3	- 4	- 4	...	...
15.....	...	- 1	- 6	+ 2	- 5	- 2	- 3	0
16.....	...	- 4	- 8	- 4	- 8	- 3	- 5	- 1
17.....	...	- 8	-10	+ 5	- 8	- 8	- 3	- 6
18.....	...	+ 1	- 9	- 1	- 8	-10	- 8	-15
19.....	...	...	- 5	...	-12	...	...	...
20.....	...	- 6	- 5	- 3	- 4	- 7	- 3	- 5
21.....	...	- 5	- 4	- 5	- 8	- 9	- 7	- 7
22.....	...	- 7	- 6	- 5	- 5	- 3	- 6	- 4
23.....	- 4	- 8	-12	-10	- 3	- 4	- 9	- 7
24.....	...	-19	-12	- 8	-12	-12	-15	-10
25.....	...	+ 5	- 4	- 6	- 7	- 7	- 2	- 7
26.....	...	...	- 1	...	- 7	...	...	...
27.....	...	- 2	- 6	- 5	- 4	- 8	- 2	- 5
28.....	...	- 2	- 8	- 5	-13	-11	- 9	- 7
29.....	...	- 6	- 6	- 4	+ 1	+ 1	- 2	- 3
30.....	...	- 2	- 5	- 7	- 6	- 9	-10	- 8
31.....	...	- 9	-10	-11	-10	-12	- 9	-10
August 1.....	...	...	- 1	- 1	0	- 6	- 3	- 4
2.....	- 2	- 8	...	...	- 7	...	...	...
3.....	...	0	- 9	-10	-11	- 9	- 4	...
4.....	...	- 5	- 4	+ 3	- 2	+ 1	...	- 3
5.....	...	- 4	- 3	- 4	- 1	- 1	- 2	- 4
6.....	...	+ 2	+ 3	+ 3	...	+ 1	...	...

NOTE.—The sign plus (+) signifies that the degree of humidity was greater at

the ground — that at 4 feet above the ground.

Observation.								
4 P.M.	5 P.M.	6 P.M.	7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Midnight.
+ 1	+ 2	+ 4	+ 3	+ 2	+ 7	...	...	...
...	...	+ 4	...	...	- 3	...	...	...
...	...	...	...	0	- 1	...	...	...
...	...	- 2	...	...	- 3	+ 4	+ 9	+ 9
- 7	...	- 7	...	...	- 4	...	...	...
...	...	- 6	...	...	- 3	...	...	...
...	...	0	...	...	- 3	...	...	...
...	...	- 6	...	...	- 5	...	...	...
...	...	- 2	...	...	- 6	...	...	...
...	...	...	...	+ 9	...	...	...	...
...	...	+ 4	...	...	+ 11	...	...	...
...	...	+ 9	...	...	+ 15	...	...	...
...	...	+ 3	...	...	+ 9	...	...	...
...	...	- 2	...	...	0	...	...	...
...	...	- 5	...	...	- 4	...	...	...
- 5	...	...	...	...	0	...	...	...
...	...	...	...	...	...	...	...	...
...	...	+ 2	...	+ 3	+ 4	...	...	...
...	...	- 3	...	- 1	+ 1	...	0	...
...	...	+ 3	...	...	+ 4	...	...	...
...	...	+ 4	...	...	- 2	...	...	...
...	...	+ 2	...	...	- 2	...	...	...
...	...	0	...	...	- 5	...	...	...
...	...	...	...	...	+ 4	...	...	...
...	...	+ 1	+ 2	+ 2	+ 3	...	...	...
...	...	...	...	...	- 1	...	...	...
- 3	...	0	...	- 2	- 1	...	+ 2	...
...	...	- 8	...	...	- 2	...	...	...
...	...	+ 1	...	...	0	...	...	...
...	...	- 7	...	...	- 3	...	...	...
...	...	...	...	...	+ 2	...	...	...
...	...	+ 2	...	...	+ 3	+ 4	+ 7	+ 3
...	...	- 6	...	...	- 3	...	...	...
...	...	- 1	...	...	+ 9	...	...	...
...	...	+ 3	...	...	- 6	...	...	...
...	...	- 7	...	...	0	...	...	...
...	...	- 3	...	...	+ 7	+ 14	...	...
...	...	...	...	- 2	...	...	...	...
...	...	- 1	...	...	- 3	...	...	...
...	...	+ 2	...	...	+ 1	...	...	...
...	...	+ 5	...	...	+ 5	...	...	...
...	...	...	...	...	+ 3	...	...	...

the lower station, and the sign minus (-) that it was less.

By laying the numbers at the bottom of p. 47, on a diagram, the march of the degree of humidity during the day-hours is easily seen; it appears that it is sensibly the same for some time in the evening hours, after which the laws which prevail during the day are completely changed.

Thus it appears that, during the day-hours, the degree of humidity is greater at the higher elevation than at the lower, that from 6^h to 9^h P.M. there appears to be but little difference, and that at night the degree of humidity is greater at the lower elevations.

From these results it is evident that observations, even up to 50 feet, give more information than could be obtained by the use of either a free or captive balloon, of the temperature and humidity of the air at moderate elevations; and if carried through an entire year, would give the seasonal as well as diurnal changes; such experiments are in progress at present, and several months' observations have already been made, the results of which I hope to lay before this Society at a future time.

VII. *Rainfall at Jerusalem during the Rainy Season of 1868-69.*

By THOMAS CHAPLIN, M.D.

Months.	Rain.	
	Number of Days on which Rain fell.	Amount.
1868.		in.
November	7	1'186
December	13	8'047
1869.		
January	15	7'715
February	12	3'265
March.....	4	1'945
April	8	2'363
May	2	0'395
Sums	61	24'916

Instrument employed, Glaisher's rain-gauge, No. 934.

VIII. *Ozone-observations.*

IN the fourth volume of the 'Proceedings' is a description of Mr. Cann-Lippincott's self-recording ozonometer. The instrument was in constant use throughout the year, and has acted well throughout. The following Table contains the monthly mean hourly values of the observed amount of ozone.

Mean Hourly amounts of Ozone on the averages of the Months from the 20th of February to the 18th of November inclusive, deduced from Observations taken at Over Court, near Bristol, in the Year 1869. Height of Ozonometer above the sea 148 feet. Lat. $51^{\circ} 32' 5''$ N., long. $2^{\circ} 34'$ W.

Test-paper, Schönbein's. Scale 0 to 10.

1869. Months.	Hours.—Morning.											
	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	12	13	14	15	16	17	18	19	20	21	22	23
Feb. 20 to end	2.5	2.5	2.3	2.3	2.1	2.1	2.0	1.7	2.0	1.8	1.1	1.6
March	2.8	3.0	2.7	2.4	2.6	2.7	2.6	2.7	2.3	1.9	1.7	2.1
April	3.0	3.2	3.3	3.2	3.1	3.3	3.3	3.2	2.9	2.4	1.7	2.3
May	3.2	3.3	3.5	3.4	3.2	3.2	3.1	3.2	3.2	2.9	2.5	2.7
June	1.3	1.3	1.2	1.2	1.4	1.6	1.7	1.7	1.5	1.6	1.2	1.3
July	2.2	2.3	2.4	2.3	2.4	2.6	2.7	2.5	2.4	2.4	1.6	1.8
August	2.2	2.2	2.4	2.2	1.7	1.9	2.0	2.1	2.1	2.0	1.5	1.6
September	4.6	4.5	4.5	4.4	4.4	4.6	4.7	4.6	4.5	4.2	3.5	3.4
October	2.2	2.3	2.2	2.2	2.1	2.3	2.4	2.4	2.1	1.9	1.7	1.6
November 18...	3.7	3.8	3.5	3.7	3.7	3.8	3.7	4.1	3.6	3.2	3.2	3.2
Means	2.8	2.8	2.8	2.7	2.7	2.8	2.8	2.8	2.7	2.4	2.0	2.2

	Hours.—Afternoon.											
	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	0	1	2	3	4	5	6	7	8	9	10	11
Feb. 20 to end	2.1	2.1	2.0	2.4	2.1	2.3	2.3	2.2	2.1	2.1	2.5	2.7
March	2.5	2.6	2.6	2.7	2.7	2.8	2.7	2.5	2.1	2.3	2.6	2.5
April	2.8	3.1	3.1	3.2	3.4	3.5	3.4	3.3	3.2	3.0	2.7	2.9
May	2.9	3.0	3.0	3.1	3.1	3.3	3.4	3.2	2.9	2.8	3.0	3.1
June	1.5	1.5	1.6	1.7	1.8	2.0	1.9	1.7	1.6	1.5	1.5	1.5
July	2.0	2.1	2.2	2.4	2.7	3.1	3.0	2.8	2.5	2.4	2.5	2.4
August	1.7	1.8	2.0	2.2	2.2	2.1	2.0	2.0	2.1	2.0	1.9	2.0
September	3.8	3.8	3.8	3.9	4.0	4.3	4.2	4.2	4.1	4.4	4.6	4.2
October	1.5	1.4	1.4	1.6	1.8	1.9	1.6	1.6	1.7	1.7	1.8	1.9
November 18...	3.1	2.8	3.3	3.4	3.5	3.5	3.5	3.3	3.1	3.6	3.8	4.0
Means	2.4	2.4	2.5	2.7	2.7	2.9	2.8	2.7	2.5	2.6	2.7	2.8

CORRESPONDENCE, &c.

The South-African Exploring Party.

At the last Meeting of the Meteorological Society its Vice-President, Dr. Mann, reported that information had been received to the effect that the South-African exploring party, under the leadership of the veteran traveller, Mr. Baines, was in the Malahili country, south latitude $19^{\circ} 42' 49''$, at the beginning of last July. Mr. Baines, under the recommendations with which he is accredited, had at that time received permission from the chief man of the tribe, holding temporary rule in consequence of the then recent death of the supreme chief Mosilikatze, to explore the entire high tableland district which lies between the Limpopo and Zambesi rivers, and to bring away gold, or any other minerals that he may find, upon the sole condition that, before leaving, he reports the actual facts of his success in the exploration to the chief.

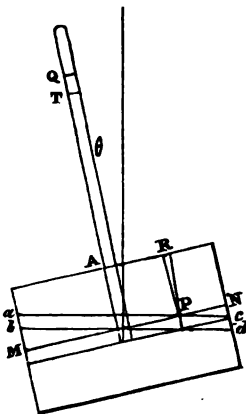
Mr. Baines is well supplied with meteorological instruments, and is observing carefully along his route. At the beginning of July, a few days, therefore, after midwinter, the lowest night temperatures within the parallel of 20° south, and with water boiling at $204^{\circ} 4$ of Fahrenheit, was $24^{\circ} 5$.

The successor of Mosilikatze is a young man who has been residing for some years in Natal under the shelter of the Colonial Government, although his claims and birth were entirely unknown to the authorities. Mr. Baines states that a deputation has been sent down to Natal by the Matabili to claim their chief. This fortunate contingency will certainly exercise a very favourable influence upon the results of this interesting and carefully planned expedition. The presence in this high interior territory of a chief who has learned to look up to British influence, will do more than anything else could, to open the door to satisfactory relations with the virtual rulers and owners of the district that it is now so desirable to examine thoroughly.

To find the Error in Reading the Cistern-Barometer if not hung truly vertical. By the Rev. W. PREVITÉ, M.A., F.M.S.

[In correction of paper No. II. Proc. 45, Nov. 1869.]

LET the figure represent the cistern and tube of a barometer hung at an inclination θ to the vertical, RP the pointer, P the zero-point. If the inclination be towards the point, P will be above the true level of the mercury, and the mercury will have to be screwed up to bring the level to the zero-point (and *vice versa*, in the opposite position of P). The mercury will thus be raised (or lowered) from T to Q in the tube. Let a be the radius of the cistern, d the distance of R from the axis of the cistern; and let ϕ be the angle between the plane through the axis of the cistern and the major axis of the elliptical surface of the mercury, and the plane through the axis of the cistern and the ivory point. Then the volume of mercury screwed into (or out of) the tube to bring the level to the zero-point will be that of length QT, where $QT = ab = d \tan \theta \cos \phi$. Let h, h' be true and apparent heights of the barometer; then



$$h = (h' - QT) \cos \theta,$$

$$= h' \cos \theta - d \sin \theta \cos \phi,$$

and error

$$= h' - h,$$

$$= h'(1 - \cos \theta) + d \sin \theta \cos \phi. \dots \dots (1)$$

This vanishes when $\theta=0$, as it should; and it is a maximum when $\phi=0$ for any given value of θ . When $\phi=90^\circ$, or 270° , the 2nd term vanishes. Also there will be two values of ϕ between 90° and 270° (θ given) for which the expression (1) is a minimum or vanishes.

Example: let $h'=30$ in., $\theta=2^\circ$, $\phi=45^\circ$, $a=1$ in., $d=\frac{1}{2}$ in. (the point being halfway from axis of cistern); then

$$\sin 2^\circ = \cdot 0349, \cos 45^\circ = \frac{1}{\sqrt{2}}, \cos 2^\circ = \cdot 99939,$$

and

$$\begin{aligned} h' - h &= 30 \times \cdot 00061 + \frac{\cdot 024}{2} \\ &= \cdot 0183 + \cdot 012 = \cdot 030, \end{aligned}$$

the error in reading; whence $h = 29\cdot 970$.

The error will obviously be less, the nearer the pointer is to the axis; and may be quite obviated by rotating the instrument and observing the behaviour of the ivory point with regard to the surface of the mercury.

To the Editor of the Meteorological Society's Proceedings.

Observatory, Mauritius.
Nov. 19, 1869.

MY DEAR SIR,—I have just time, and no more, to say that the November shower of meteors was seen here on the morning of the 14th. From midnight to 4^h 40^m A.M., 439 meteors were counted by three observers, and of that number, 427 were seen between 3^h 20^m and 4^h 40^m A.M. The time of maximum intensity was about 4^h 9^m A.M., and the radiant-point in the Sickle of Leo. But I have not yet had time to analyze the observations and determine the exact position of the point.

Yours truly,

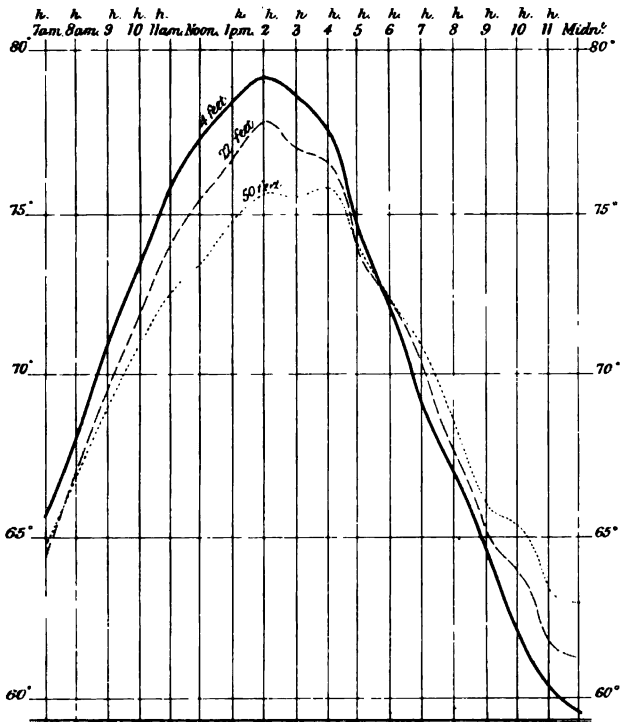
C. MELDRUM.

James Glaisher, F.R.S.

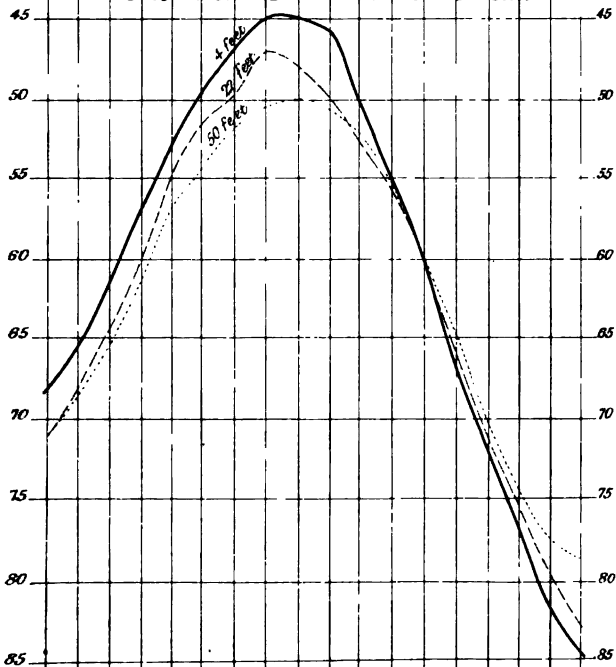
Proc. Met. Soc. Vol V. Pl. I

Curve _____

22	"	"	"	"	"	_____
50	"	"	"	"	"	.....



HUMIDITY OF THE AIR	7 ^h	A.M.	TO	MIDNIGHT.
---------------------	----------------	------	----	-----------



(Deduced from observations made at the Royal Observatory Greenwich.)



ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. Taylor and Francis, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line	0	0	6	Bills, half-sheet and line	1	10	0
Half a page	0	17	6	" whole sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY.

Session 1869-70,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1869. November	17	1870. March	16
1870. January	19	" April	20
" February	16	" June	17

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 1s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 13, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Hours of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

"Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. Belville's *Manuals*."—*Observer*.

TAYLOR AND FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, F.R.S., SECRETARY.

1870, FEB. 16.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
IX. On the Influence of the Moon upon the amount of Rainfall.— J. C. Nicolson, M.R.C.S., F.M.S. (Plate II.).....	50
X. The Weather of 1860, as observed at the British Consulate, Soutar, lat. 41° N., long. 29° 3' E.—Sergeant W. H. Lyne, R.E. (Com- municated by R. Main, M.A., F.R.S.)	61
II. On the recent (current) Appearance of the Aurora.—J. Glaisher, F.R.S. (Plate III.)	67

Correspondence, &c.:—

Temperature and Rainfall at Burnham, Westgate, Norfolk.—H. B. Wyllie, Esq.	68
Meteorology at the Cape of Good Hope.....	64

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, March.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1870, FEBRUARY 16. [No. 47.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Andrews, Frederick, 52 *Finchley Road*, N.W. ;
Miller, Samuel H., F.R.A.S., 8 *Victoria Road*, *Wisbeach* ;
North, Alfred, F.R.G.S., 20 *Royal York Crescent*, *Clifton*, *Bristol* ;
were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society
were read.

IX. *On the Influence of the Moon upon the amount of Rainfall.*
By J. C. BLOXAM, M.R.C.S., F.M.S.

[PLATE II.]

THE statement Mr. Glaisher has given in the 43rd No. of 'Proceedings' in reference to the influence of the moon on rainfall is so interesting, and so decisive in showing that the moon has such influence, that I was induced to devote some time to the further investigation of the subject, hoping that with such ample materials at hand I might discover more fully the laws of the moon's control over rainfall ; and I imagine that I have collected some results worth communicating. The first step necessary in

the investigation was that of converting the daily amounts of rainfall through the cycle of a lunation, as given in Mr. Glaisher's Table I. (see vol. iv. p. 332), into average (or mean) daily values, so that the daily progression should be correctly and definitely laid down. In order to discover the connexion between two movements, it is necessary to know, first, the direction they really move in. Each day's rainfall being laid down correctly, the daily progression then admits of correlation with that of the moon's age, and the extent of the dependence of the one movement on the other may be ascertained with more certainty.

It is necessary that the process should be stated by which the actual amounts of rain were exchanged for normal average values. The process used is not so perfect a one for this investigation as it is for many others of a like nature, because the value registered for one of the days in the series does not, in this instance, stand on the same footing with those for the other days. The last day of the lunation includes 45,843 seconds only, instead of 24 hours; and the amount of rain for this number of seconds being 23.85 inches, the value 44.95 in. had to be introduced as the quantity due to 24 hours. The values for the thirty days being by this means made uniform, the accidental irregular variations in their amounts had to be smoothed out. In order to effect this, thirty *compound* values were obtained. The sum of the amounts registered for the days 29, 0, and 1 was set down as a corrected value for 0 day. The value for day 1 was in like manner obtained from the days 0, 1, 2, and so on throughout the series, the days 28, 29, 0 contributing of course to the quantity for day 29. These corrected values were then, in their turn, grouped in the same manner, and this process was carried through a third time. Very little difference is made in the relative values by repeating the process again; but the third series differs materially from the second. The values in the second series rise daily from day 0 to day 5, and fall on day 6, to rise again on days 7, 8, and 9, and so attain the maximum. Then five days ensue with diminishing values, and then three with increasing values, another maximum being attained on day 17. Seven days of decrement then occur, and the next day, 25, is one of increment; and then days 26, 27, and 28 give diminishing values, that for day 28 being the minimum; day 29 is one of increase, and day 0 is one of decrease. There are here several divergences of single days, viz. 0, 6, 25, 29, and these divergences are all obliterated in

the third series. The permanency of the curves after the third smoothing goes far to show that they are normal and average curves; and they are adopted as such. The corrected values have next to be reduced to their original *scale*, and this is done by dividing each by the number 27. Then the value obtained for the day 29 has to be restored to that belonging to 45,843 seconds, this value being 22.568, instead of 42.524 for the 24 hours. This last step brings out the inconvenience of the last day not being one of 24 hours. It so happens that the rainfall on day 29 was great as compared with that of each of the six days nearest to it, with only a nominal exception; this leads to a part of the excess being distributed amongst these six nearest days. The sum total of the third set of combinations, when divided by 27, ought to be identical with the sum total of the numbers used for the combinations, and it is so; but then the quotient ought to be identical also with the sum total of the "sums" of Mr. Glaisher's Table, and this is not the case. The 21.10 added to the 23.85, in order to make up the proportional quantity for 24 hours, is in part absorbed by the six nearest days, and of course it remains so appropriated after the value obtained for day 29 has been reduced to the quantity due to 45,843 seconds; and thus the sum totals do not agree, the difference being 1.14. If 43.81 is substituted for 44.95 ($44.95 - 1.14 = 43.81$) as the value for the *whole* day 29, the sum totals then agree. The values for the seven days implicated, as they come out with this correction, are given in a supplementary form in Table I. and in Plate II. diagram 1; and it is observable that by thus eliminating the questionable quantity, the value for day 29 comes to be very decidedly the lowest of all.

Of course the daily values thus determined do not differ greatly from those given in Mr. Glaisher's Table; but the smoothed line, nevertheless, shows distinctly a peculiarity which was not very noticeable in the original line. Shortly before the date of full-moon the order of progression is reversed, the values for rainfall diminish from the maximum, on day 9, to nearly the mean amount on days 14 and 15, and then they rise to a second maximum on day 18. As it is this curve that the interest of the present communication mainly depends on, it may be well to show that it has a *bonâ fide* existence. Each of the ultimately adopted values involves, in varying degrees, seven of the "sums" in Mr. Glaisher's Table; but never more than 7. Consequently, no day earlier than day 15, and none later than day 21, affects the value

given to the day 18; and the extreme days (15 and 21) can have but little influence, comparatively, on the value obtained for the central day (18), unless they happen to diverge greatly from the mean line. This shows that the maximum at day 18 actually exists in the original numbers; and the minimum given to days 14 and 15 has the same warranty.

The largest amounts of rainfall occur at dates when the moon gives much light to the earth, and when it is, therefore, probable that she gives heat to the upper strata of the atmosphere. The amount of rainfall increases daily from the last day of the lunation to day 9, and it diminishes daily from day 18 to day 29. It appears therefore to be a law that the fall of rain is greater or less according as the surface of the moon reflecting light (and presumably heat) towards the earth is greater or less. Nevertheless, the rainfall is only a little above the mean on the day of full moon. There must, therefore, be some other agency powerful enough to counteract this law at the middle period of the lunation.

It may be assumed that the moon's rays do not favour condensation of vapour; but, if they raise the temperature of the upper strata of the atmosphere, this may lead to the atmospheric vapour ascending and accumulating in the upper strata; and then, when the moon retires, this vapour would be condensed and precipitated to the earth. The sun augments the atmospheric vapour by warming the surface of the earth, which is the source of the vapour, and even atmospheric temperature is acquired from the earth rather than direct from the sun. The temperature acquired from the moon is obtained direct from the moon, and the vapour probably rapidly loses temperature when the source of the heat departs. The particles of vapour, possibly, part with their heat to the particles of the permanent gases in contact with them, as the earth parts with its heat to the atmosphere. Assuming that the rainfall increases with increase of moon *power*, it is to be expected that the rainfall will be the greater for the moon's influence being maintained for a greater length of time; and this appears to be the fact. The period of time the moon remains above the horizon each day increases as the rainfall increases upon the earlier days of the lunation, and it diminishes as the rainfall diminishes upon the later days; and this lunar condition progresses with a reversed curve at the middle period of the lunation, as the rainfall does. The rainfall attains to the maxi-

mum on day 9, and the maximum duration of this position of the moon is on day 10. A second maximum for rainfall occurs on day 18, and this is accompanied with a second maximum for the moon's position on day 19. The low value between these two maxima for rainfall occurs on days 14 and 15, and a low value for this lunar condition occurs on the same two days.

The curves for rainfall, as exhibited in diagram 1, accord more closely with those in diagram 2 than the rainfall does with the age of the moon; but still the daily variations in the amount of rainfall are not yet fully accounted for; they must be influenced in a considerable degree by other conditions connected with the age of the moon, in addition to those that have been referred to. The accumulation of vapour under the moon's influence in the higher strata of the atmosphere may be expected to be most abundant at the periods in which the moon is above the horizon together with the sun. The quantity of vapour diffused through the atmosphere increases with the heat of the sun, and there is thus the more vapour for the moon to dispose of to the higher strata. The sun draws vapour from the surface of the earth into the atmosphere; the moon draws vapour from the higher strata of the atmosphere and transfers it to still higher strata. If it were not for the sun's action the moon would not have so much vapour to dispose of; if it were not for the moon's action clouds would form and the sun's heating and vaporizing power thus be checked. The length of time the sun and moon are together above the horizon on each day of the lunation is given in Table III., and shown by diagram 3; and it is here readily seen why so great a diminution of rainfall occurs at the time of full moon. This diagram also shows very readily why the rainfall on day 9 is so much greater than it is on day 18: the sun and moon are two and a quarter hours longer above the horizon on the former day than on the latter.

The rain-values decline at the rate of 0·37 per day from day 25 to day 29, and they rise at the rate of 0·62 from day 0 to day 4. This is quite in accordance with the indications given by diagram 2. The decrement in the rainfall in the former of these periods, and the increment in the latter, seem to be mainly dependent on the changes in the age of the moon.

Table II. and diagram 2 include seventy-four lunations—beginning with 31st of December, 1861, and ending with 24th of December, 1867. Table III. and diagram 3 include thirty-seven lunations—beginning with 4th of January, 1865, and ending with

24th of December, 1867. These periods suffice, it is hoped, for giving satisfactory averages. Tables II. and III. give mean daily values for the periods they embrace. Diagram 2 was constructed with aggregate numbers, and it is these aggregate numbers that are put in the margin. Diagram 3 embraces three years, and the aggregate numbers were divided by 3 for the construction of the diagram, and the numbers in the margin are mean aggregates for a year. Diagrams 1 and 2 are fairly correlative, the range of the values being nearly the same in each; but the range of the values for diagram 3 is 20 to 1 as compared with the others,—diagram 3 starting with a *very* low number, whilst the others start from high numbers.

The process by which the values were ascertained for the day 29 in diagrams 2 and 3 perhaps ought to be explained. All the values for day 28 that were followed by a value for day 29 were placed in a group and added together. Having, thus, values for the fractional day 28, the fractional day 29, and the whole day 28, the rule-of-three then gave the proportionate value for the whole day 29. A second proportionate value was obtained in the same way from day 0, and the mean of these two results constituted the adopted value for the entire day 29: this being marked on the diagram gave the direction the line should take from day 28 to the end of the lunation.

The above statements would lead to the conclusion that on day 9 in the lunation there would be a small amount of rain between 1^h 42^m and 18^h 25^m, taking the year's average, and that there would be much rain in the remaining portion of the day, the moon being above the horizon during the first-named period. The sun and moon are both above the horizon on day 9 between the hours 1 and 6; these hours would, therefore, be particularly exempt from rain, and there would be a short period opposed to this in which the rainfall would be very heavy. On day 14, the moon being above the horizon from 5^h 25^m to 17^h 16^m, this would be the finer part of the day. These hours, however, of course vary with the date in the year.

TABLE I.

Age of the Moon.	Amount of Rainfall.	Amended values.
days.	ins.	ins.
0	42°75	42°50
1	42°88	42°755
2	43°57	43°53
3	44°38	.....
4	45°25	.....
5	45°56	.....
6	45°72	.....
7	46°04	.....
8	46°61	.....
9	46°84	.....
10	46°55	.....
11	45°96	.....
12	45°47	.....
13	45°08	.....
14	44°93	.....
15	44°92	.....
16	45°255	.....
17	45°44	.....
18	45°56	.....
19	45°28	.....
20	44°99	.....
21	44°55	.....
22	44°30	.....
23	44°06	.....
24	44°00	.....
25	43°70	.....
26	43°30	43°26
27	42°71	42°55
28	42°61	42°36
29	{ 22°56 } =42°52	{ 22°41 } =42°23

TABLE II. Giving the Daily duration of the Moon's position above the Horizon.

Age of the Moon.	Moon above Horizon.
days.	h m
0	11 37
1	11 36
2	11 37
3	11 38
4	11 38
5	11 40
6	11 46
7	11 55
8	12 5
9	12 13
10	12 18
11	12 17
12	12 16
13	12 16
14	12 13
15	12 13
16	12 14
17	12 16
18	12 15
19	12 16
20	12 10
21	12 1
22	11 56
23	11 47
24	11 41
25	11 32
26	11 32
27	11 10
28	11 35
29	11 34

TABLE III. Giving the Daily periods that Sun and Moon are together above the horizon.

Age of the Moon.	Sun and Moon above Horizon.
days.	h m
0	11 30
1	11 6
2	10 12
3	9 18
4	8 24
5	7 36
6	6 54
7	6 18
8	5 36
9	5 0
10	4 18
11	3 24
12	2 12
13	1 42
14	0 54
15	0 30
16	1 6
17	2 0
18	2 48
19	3 42
20	4 30
21	5 12
22	5 54
23	6 30
24	7 18
25	8 0
26	8 54
27	9 42
28	10 36
29	10 40

X. *The Weather of 1869, as observed at the British Cemetery, Scutari, lat. 41° N., long. 29° 8' E.* By Sergeant W. H. LYNE, R.E. (Communicated by Rev. R. MAIN, M.A., F.R.S.)

JANUARY.

THE barometer was generally high during the month; it was highest (30·430) on the 3rd, lowest (29·558) on the 22nd. The

highest mean daily temperature ($54^{\circ}9$) was attained on the 1st, the lowest ($22^{\circ}1$) on the 25th. Frost, with snow- and hail-squalls, set in on the night of the 16th and continued, with the exception of a few hours on the 21st and 22nd, until the 28th; during the night of the 25th the temperature fell to 13° , the lowest temperature for many years. Frost occurred every night from the 16th to the end of the month. Snow fell on eleven days; hail on one (for rainfall, see Table I.). Prevailing winds were from N.E., N., and E.

FEBRUARY.

The barometer was generally above 30 inches; it was highest (30.414) on the 6th, lowest (29.894) on the 27th. The highest mean daily temperature ($51^{\circ}6$) was reached twice, viz. on the 18th and 22nd, the lowest ($36^{\circ}4$) on the 6th. Frost occurred on eight nights; hoar frost was frequent. Prevailing winds were from S.W., S., N., and N.E. The weather generally fine.

MARCH.

Barometer readings constantly under 30 inches; it was highest (29.915) on the 10th, lowest (29.295) on the 25th. The highest mean daily temperature ($61^{\circ}6$) was on the 18th, the lowest ($42^{\circ}7$) was on the 6th. The weather was generally wet and dull. There was no frost. A slight thunderstorm occurred on the 5th, and lightning was seen on the 3rd. There was a gale from S.W. on the night of the 22nd. Prevailing winds were from the S., S.W., and S.E.

APRIL.

The barometer was highest (30.283) on the 11th, lowest (29.802) on the 4th. Weather generally fine. The highest mean daily temperature ($64^{\circ}7$) was on the 18th, the lowest ($43^{\circ}4$) on the 5th. A shock of earthquake was felt at about 1.10 P.M. on Sunday the 18th: a very hazy state of the atmosphere prevailed during the day, and a warm wind was blowing from the S.E. Prevailing winds during the month were from S., N., and N.E.

MAY.

The barometer was highest (30.115) on the 6th, lowest (29.657) on the 17th. Weather fine, with very little rain. A distant

thunderstorm was noticed on the 4th, and lightning was seen on the 17th. The highest mean daily temperature ($75^{\circ}2$) was reached on the 28th, the lowest ($58^{\circ}1$) on the 6th. Prevailing winds were from S.W., N.E., N., and S.

JUNE.

The barometer was highest (30.044) on the 18th, lowest (29.659) on the 30th. The highest mean daily temperature ($85^{\circ}9$) was on the 22nd (which was the hottest day of the year): on this day the maximum temperature in the shade rose to the extraordinary height of $108^{\circ}6$; this great heat was attained about 3 P.M., when a change of wind from S.W. to N.E. took place, the N.E. wind bringing down the radiated heat from the parched ground on the N.E. land side of the place of observation: before the change took place, the thermometer stood at 97° . The lowest mean daily temperature (64°) was on the 7th. Thunderstorms occurred on the 3rd, 4th, 12th, and 30th; thunder was heard on the 5th and 6th, and lightning was seen on the 29th. Prevailing winds were from N., S., and S.W.

JULY.

The barometer was highest (30.110) on the 11th, lowest (29.632) on the 5th. There was a thunderstorm on the 23rd; thunder was heard on the 5th and 22nd, and lightning was seen on the 4th. Fog prevailed on the morning of the 2nd. The highest mean daily temperature ($80^{\circ}4$) was on the 29th and 31st, the lowest ($69^{\circ}2$) on the 13th. Prevailing winds were from the N.E., N., and S.W.

AUGUST.

Barometer generally under 30 inches; it was highest (30.017) on the 13th, lowest (29.600) on the 11th. Thunderstorms occurred on the 25th and 26th; thunder was heard on the 23rd and 24th, and lightning was seen on the 22nd and 23rd. The highest mean daily temperature ($83^{\circ}1$) occurred on the 11th, the lowest ($66^{\circ}9$) on the 13th. The prevailing winds were from N.E., N., S.W., and S.

SEPTEMBER.

The barometer was highest (30.166) on the 27th, lowest (29.867) on the 21st. Weather generally fine. The highest mean

daily temperature ($74^{\circ}8$) was attained on the 1st, the lowest ($59^{\circ}2$) on the 25th. Lightning was seen on the 3rd. There was a gale from the north on the 4th. Prevailing winds were from N.E., N., S., and S.W.

OCTOBER.

The barometer was highest (30.305) on the 11th, lowest (29.670) on the 7th. Lightning was seen on the 5th and 26th. Fog prevailed on the night of the 4th and morning of the 5th, and fogs were frequent in the Bosphorus during the morning hours. The highest mean daily temperature ($68^{\circ}3$) was on the 1st, the lowest ($49^{\circ}7$) on the 10th. New snow was seen on Mount Olympus on the 13th, which had probably been deposited between the 6th and 10th. Gales from N.N.W. and N. occurred on the 8th, 9th, and 10th. Prevailing winds were from N., S.W., S., and N.E. Calms and light airs were frequent.

NOVEMBER.

Barometer was highest (30.823) on the 14th, lowest (29.367) on the 5th. Passing thunderstorms occurred on the 4th and 12th; lightning was seen on the 16th, on which day hail fell. The weather during the month was generally dull and boisterous, with many wet days. The highest mean daily temperature ($61^{\circ}9$) was on the 11th, the lowest ($34^{\circ}7$) on the 18th; during the night of the 18th the temperature fell to $27^{\circ}2$, a degree of cold very unusual in the month of November. Gales were frequent, occurring on the 7th, 11th, 12th, 14th, 15th, 16th, and 29th. Prevailing winds were from S.W., S., N., and W.

DECEMBER.

The month was more than usually mild, and the barometer generally above 30 inches; it was highest (30.556) on the 6th, lowest (29.688) on the 19th. The highest mean daily temperature ($58^{\circ}3$) was reached twice, viz. on the 28th and 29th, the lowest mean temperature also twice, viz. on the 10th and 19th. There was a slight frost during the night of the 19th. Fog prevailed on the night of the 12th and morning of the 13th. There was a gale on the 18th and 19th. Prevailing winds were from the N.E., S.E., S., and S.W.

TABLE I. Monthly Averages and Means &c., 1869.

Month.	Barometer Corrected for Temperature.		Exposed Thermometers on "Glaisher's stand."				Rain, Hail, or Snow.		Average Mean Tempera- ture of 1868.	Excess or defect of 1869.
	Approximate Mean Pressure.	Range of Pressure.	Average Highest Tempera- ture.	Average Lowest Tempera- ture.	Approximate Mean Tempera- ture.	Mean Daily range of Tempera- ture.	Amount collected 6 inches above ground.	Number of Days on which Rain fell.		
January	inches. 30.160	inches. 0.872	42.7	29.3	36.0	13.4	inches. 2.09	20	42.4	-6.4
February	30.051	0.520	50.5	35.2	42.8	15.3	0.74	10	39.0	+3.8
March	29.605	0.622	60.0	43.3	51.6	16.7	2.59	20	42.9	+8.7
April	29.328	0.981	61.4	42.3	51.8	19.1	0.59	9	50.3	+1.5
May	29.888	0.458	75.6	51.7	63.7	23.9	0.35	6	62.1	+1.6
June	29.871	0.385	85.6	59.9	72.7	25.7	0.67	6	71.4	+1.3
July	29.840	0.478	87.7	61.3	74.5	26.4	0.79	3	74.7	-0.2
August	29.803	0.417	90.0	65.0	77.5	25.0	1.99	5	75.2	+2.3
September	29.947	0.479	79.1	56.7	67.9	22.4	1.57	9	70.1	-2.2
October	29.990	0.635	71.6	52.1	61.9	19.5	3.37	7	65.5	-3.6
November	29.900	0.956	59.3	42.9	51.1	16.4	4.30	15	50.8	+0.3
December	30.085	0.868	55.1	41.5	48.3	13.6	2.26	12	47.1	+1.2

TABLE II. Extremes and Ranges, 1869.

Month.	Highest Temperature during the Month.	Lowest Temperature during the Month.	Range of Temperature.	Greatest range of Temperature in Twenty-four Hours, from 9 A.M.	Least range of Temperature in Twenty-four Hours, from 9 A.M.	Greatest Rainfall in Twenty-four Hours, from 9 A.M.
January	61°2 on the 1st	13°0 on the 25th	48°2	22°4 on the 26th	4°2 on the 23rd	0°38 on the 2nd
February	62°4 " 22nd	27°8 " 6th	34°6	21°6 " 22nd	7°0 " 5th	0°34 " 3rd
March	75°4 " 13th	36°8 " 6th	38°6	27°6 " 13th	8°4 " 27th	0°49 " 5th
April	76°0 " 18th	34°0 " 15th	42°0	28°6 " 20th	9°0 " 25th	0°19 " 29th
May	91°0 " 26th	40°4 " 8th	50°6	33°4 " 26th	15°2 " 1st	0°13 " 19th
June	103°6 " 22nd	53°2 " 7th	50°4	35°4 " 22nd	17°2 " 1st	0°25 " 30th
July	94°0 " 26th	54°4 " 13th	39°6	31°8 " 2nd and 20th	15°0 " 17th	0°66 " 23rd
August	99°8 " 11th	55°2 " 13th	44°6	33°4 " 10th and 11th	19°2 " 27th and 28th	1°35 " 25th
September	88°0 " 1st	50°8 " 15th	37°2	30°2 " 15th	14°4 " 25th	0°38 " 4th
October	81°6 " 1st	41°8 " 10th	39°8	27°0 " 3rd	7°0 " 9th	2°07 " 7th
November	70°4 " 12th	27°2 " 13th	43°2	34°0 " 12th	8°6 " 15th	1°06 " 4th
December	66°8 " 26th	31°6 " 19th	35°2	19°6 " 12th	7°2 " 10th	0°38 " 9th

From the last column of Table I. it will be seen that the months of January, September, and October were colder than the same months of 1868; that July and November were about the same as in 1868, and that all the other months were warmer.

The approximate mean temperature of the year (58·3) was 1°·3 above the average of the preceeding seven years.

The highest and lowest temperatures in the eight years just ended were recorded in 1869, viz. 103°·6 on the 22nd of June, and 18° on the 25th of January.

February, April, May, June, and July were dry months, the total amount of rain collected during these months being only 3·14 inches.

The total rainfall of the year (21·31, on 122 days) was 9½ inches below the average of the seven years ending 1868, the days on which rain fell being an average number. The rainfall, however, is very irregular; in 1863 it was less than 15 inches, in 1866 more than 40 inches.

Thunderstorms and gales were less frequent and of shorter duration than usual.

The observations are taken near the sea, and 60 feet above the sea-level.

XI. *On the recent frequent Appearance of the Auroræ.*

By JAMES GLAISHER, F.R.S.

SOMETIMES there are long intervals during which no auroræ are seen, and the magnets have their usual diurnal movements only; and there are other times when the auroræ are frequent, and the magnets are much disturbed. Since February 1 there have been several auroræ, viz. :—on February 1, seen at Greenwich, Stockholm, Valencia, &c.; on February 11, at Greenwich and Herno-sand; at midday of the 12th at Greenwich; on the 17th, at Paris and Leipsic; on the 19th, at Greenwich and Stockholm; and on the 23rd at Greenwich and Stockholm. The most remarkable of these was that of the 1st, with a succession of fine arches, and that of the 12th seen by daylight. The following are the accounts :—

The Aurora Borealis of February 1st, 1870.

THE ASTRONOMER ROYAL, Royal Observatory, Greenwich.

At 7^h, or shortly after, there was a mass of white light of considerable brilliancy low in the N.E. (possibly 15° high) extending through α and β Ursæ Majoris and somewhat further. In the neighbourhood of these stars it bifurcated: one branch of no great brilliancy extended perhaps 20° towards the magnetic zenith; one passed through γ and δ Ursæ Majoris and through α Draconis, and perhaps 15° further. As time went on, this westerly branch became more definite and more important.

About 7^h 10^m the westerly branch was the more luminous; the original easterly mass attracted little attention.

About 7^h 14^m the greater part of the westerly branch showed, indistinctly, a combed or streaming structure; but its western extremity had widened and formed itself into a well-defined beam pointing to the magnetic zenith. The centre of its general mass was on α Andromedæ. Its brilliancy far exceeded that of any other aurora that I have seen. It was brightest about 7^h 15^m or 7^h 16^m.

The streamer-structure or beam-structure of the western arch became more distinct, and now it was seen that all the beams were travelling laterally towards the west. The great beam abandoned α Andromedæ, and its centre became midway between α Andromedæ and γ Pegasi. In the neighbourhood of α Pegasi its lower end was cut off in a remarkably *tranché* manner; I know not whether by clouds*. There was a little reddish light scattered about. This was the state about 7^h 20^m.

The spaces between the small beams of the arch were now wider than the small beams themselves.

The distinct phenomena gradually faded; though for some time there were confused masses of light mixed with cloud, and a mass of light in N.E.

W. ELLIS, F.R.A.S., of the Royal Observatory.

I have frequently seen more brilliant displays of aurora than that of last night, taken as a whole; but there were peculiarities

* I am assured by the ladies who were viewing the aurora that the beam was not cut off by clouds, and that stars were seen below.

in that of last night,—the *very rapid* shifting of the beams (as it appeared) towards the west, and the brilliancy (the extreme brilliancy) of the western beam of light. It seemed to me that this beam grew most in brightness at the time at which the beams were shifting westward, as mentioned. It was sharply defined on the south side at *a*, and at the lower extremity *b*; and I do not believe that it was cut off by cloud at *b*, at least such was the opinion I formed at the time.



G. S. CRISWICK, of the Royal Observatory.

Walking along the Old Kent Road I noticed, at 6^h 30^m P.M., much white light about the N.E. and N.W., which I thought at the time was thin cloud illuminated by the light of London; but soon after 7^h, a very fine auroral streamer appeared in the N.W., pointing to the zenith, the side towards the west being very sharply defined, that to the north cumulus-like. I noticed between 7^h 15^m and 7^h 40^m three separate displays of streamers moving from east to west: the first display was by far the finest; the last one continued scarcely a minute. Just before the first set of streamers appeared, a very fine arc was visible, extending from the patch of light in the north-east to the base of the great western streamer. Surrounded by houses, I could not observe the lower parts of the aurora. The points of the moving streamers, seen above the houses, looked not unlike the teeth of some large and slowly revolving wheel.

W. C. NASH, F.M.S., of the Royal Observatory.

^h ^m

- 7 42 A brilliant white streamer observed, covering α Andromedæ and tapering off towards β Andromedæ.

The streamer gradually moved westward.

- 7 46 Across γ Pegasi; becoming fainter.

- 7 56 5° or 6° west of γ Pegasi; very faint.

After 8^h sky very cloudy; diffused light in north.

10^h intense reddish light in west; sky cloudy.



THOMAS WRIGHT, of the Magnetical and Meteorological Department, Royal Observatory.

- h m
6 45 A faint white cloud visible in N.E. immediately over Ursa Major, its lower edge sharply defined, its upper edge much blurred.
- 6 47 At this time it appeared to prolong itself rapidly towards the west, and to form an ill-defined arch, whose crown was at an altitude of about 40° . Immediately beneath the centre of the arch a long narrow horizontal band of light became visible.
- 6 50 } The western extremity of the arch now rests on the
to } horizon perpendicularly below α Andromedæ. About
6 55 } $6^h 58^m$ the arch seemed to resolve itself into a multitude of parallel bands of vertical streamers moving rapidly from east to west, as if driven by the wind, and at the same time pulsating through their length. These apparently seemed to condense into one large burst of red light in the west. The narrow band mentioned above also resolved itself into parallel bands similar to those in the arch, and had the same apparent motions.
- 6 58 The streamers have disappeared, and the arch and secondary arch below present an appearance like the folds of a curtain.
- 7 0 All traces of the arches have now disappeared, and nothing is visible except a patch of faint white light covering the space comprised between α , β , γ , and δ Ursæ Majoris.
- 7 5 The light in the east is now very intense.
- 7 10 } The arch has again formed in a similar manner to the one
7 30 } described above, viz. by prolonging itself from the east and terminating, as before, in a grand burst of red light in the west.
- The arch again became broken up into streamers, having the same characteristics as those before mentioned.
- 7 45 The light is now much fainter, and large black clouds are visible on north horizon.
- 8 0 Faint red light in west.
- 8 15 Sky covered with cloud.
- 9 45 Clouds have cleared partially away leaving a narrow band of luminous matter, about 3° wide, visible, passing

across the zenith, and terminating on the east and west horizons. Its position in the zenith would be more accurately described as passing between α and β Geminorum and a little below β Tauri.

G. L. SCHULTZ, of the Magnetical and Meteorological Department, Royal Observatory.

[PLATE III.]

A fine aurora was observed on this night. When first observed (about 6^h 50^m) it consisted of two concentric rings of streamers, the upper one being somewhat broken and about the elevation of Polaris, the lower about 10° beneath. The upper streamers were longer and further apart than the lower ones; but the streamers from both rings were moving very quickly from east to west: at 6^h 57^m a bright streamer like an ill-defined cloud was seen to rise in the west: at 7^h all had disappeared.

Shortly after 7^h a bright light like a hazy white cloud commenced rising in the N.E., about 20° above the horizon (Plate III. sketch 1). At 7^h 10^m another bright cloud formed in the N.W., and, being split up into two bands, formed with the previous light (which had become gradually brighter) a broken arch, the break occurring a little to the east of Polaris; dark auroral clouds now became visible in the north, and a column of light shot up from the arch at the eastern end of the break (sketch 2), covering the constellation of Ursa Major and reaching upwards about 20°. At 7^h 15^m fine streamers shot up from the western half of the arch; they moved rapidly westward and seemed to resolve themselves into one bright streamer in the west, rapidly becoming faint and disappearing with the rest of the arch about 7^h 19^m.

At about 7^h 22^m the dark clouds in the north became conspicuous, and the light behind became more intense, the brightest part being around α Cygni, and a bright patch of light formed at this time in the east. Above, at the elevation of Polaris, a well-defined arch of short streamers was seen, the streamers stationary (sketch 3). 7^h 35^m the arch grew broader and the streamers less defined (sketch 4), but the light behind the clouds became more intense. At 7^h 40^m a second arch formed beneath the former, concentric with it, and well-defined streamers issuing from both, moved rapidly westward. 7^h 42^m a fine bright streamer

of intense light, about 35° long, shot up in the west at the extremity of the bottom arch, and if produced would point from magnetic north (sketch 5). $7^h 48^m$ no arch was visible, but the light in the north became more extended (sketch 6), the most intense portion still continuing in the N.W. around α Cygni; from thence faint streamers shot up to a great elevation, the dark clouds at this time well defined. The bright streamer in the west which had, during this time, been moving more to the west and past α Andromedæ, now grew fainter and had disappeared about $7^h 59^m$.

At $8^h 17^m$ the light in the north had increased and seemed to be rising. A dark space of about 10° separated the light from the horizon, the light being convex towards the horizon. No streamers were seen; the light became broken up at $8^h 34^m$, when thin clouds covered the sky. Nothing remarkable occurred after this till about $9^h 45^m$, when a bright band of light became visible in the zenith, momentarily increasing in brightness and stretching in the direction of the prime-vertical to the magnetic meridian; this light appeared to move southward, and disappeared in some minutes.

The light in the north continued till midnight; the sky was generally covered with light clouds.

WILLIAM MARRIOTT, of the Magnetical and Meteorological Department, Royal Observatory.

- | h m | |
|------|--|
| 6 35 | A fine auroral arch was observed, the centre of the arch being about the elevation of Polaris, with streamers moving rapidly from E. to W. |
| 6 55 | A bright streamer like an ill-defined cloud rising in the W. |
| 7 0 | All has now disappeared; a bright light rising in the N.E., and rapidly forming an arch. |
| 7 10 | Two well-defined arches have formed, the upper one above Polaris, and the lower one a little below; splendid streamers from upper arch reaching up to β Aurigæ, and moving from E. to W. |
| 7 13 | White patch forming in midst of Ursa Major; streamers in west moving rapidly up to Serpens; the streamers in the zenith moving from E. to W. over 15° in $10'$. |

- h m
7 15 A splendid streamer, at the western extremity of the upper arch, reaching up nearly to the magnetic zenith, passing through γ Pegasi and α Andromedæ; a break in the upper arch of about 10° at α Ursæ Majoris, with a burst of light and streamers shooting up from between α and β Ursæ Majoris.
- 7 19 The streamer in the west becoming fainter; a row of streamers at elevation of Polaris, but the streamers are stationary; a bright light in the magnetic north.
- 7 21 Patch of light in E.
- 7 22 Bright light in N. by W.
- 7 23 Streamers in zenith have disappeared; also the lower arch.
- 7 26 Streamers moving rapidly from E. to W.; large streamer in magnetic north shooting up to the zenith.
- 7 27 A well-defined but faint arch above Polaris.
- 7 28 A second arch forming about 10° below Polaris.
- 7 29 Streamers shooting up from upper arch, and moving from E. to W.
- 7 31 The upper arch has disappeared.
- 7 32 Three streamers in Ursa Major moving along the arch.
- 7 34 Streamers shooting up in zenith, at elevation of Polaris, and becoming bright. The light in the magnetic north has nearly disappeared.
- 7 35 Arch nearly complete with streamers shooting up.
- 7 36 Streamers shooting up and moving rapidly from E. to W. Centre of arch is about 10° east of Polaris.
- 7 39 Second arch forming, with streamers moving rapidly; the space between the two arches is about 5° .
- 7 40 The light in magnetic north becoming more extended.
- 7 44 A splendid streamer of a white or bluish-white colour in west; centre of streamer in γ Pegasi, and reaching up to the magnetic zenith.
- 7 45 Both arches have disappeared.
- 7 47 The streamer is now due W.
- 7 52 Bright cloud, which had risen from near the horizon and has been covering α Cygni for some time, has disappeared.
- 7 57 Streamer in W. about 10° west of γ Pegasi, still visible but faint.
- 8 0 Streamer in W. has disappeared.

- h m
 8 2 Light clouds or streamers radiating from a point about 20° above the northern horizon, which have been forming for some time, are very bright.
- 8 11 The light clouds are moving to the east, centre of arch now in astronomical north; the portion in the magnetic north is of a bright bluish colour.
- 8 15 Cloud in the magnetic north is just below α Cygni, and is very bright, with faint streamers reaching up to the zenith.
- 8 19 Cloud becoming much brighter, and moving slowly to the E.
- 8 31 The cloud is now breaking up.
- 8 32 The cloud is breaking up rapidly.
- 8 34 The cloud in N.E. becoming of a reddish tinge.
- 8 41 The auroral clouds have disappeared, and the sky is now becoming covered with cloud.
- 8 45 } During this period the sky was generally covered with
 to } cloud; but the north was illuminated with a bright
 9 25 } light.
- 9 33 A band of white light stretching from east to west, south of zenith, passing through Gemini; the width of the band is about 4° .
- 9 37 The band of light is now moving south very slowly; the part east of Gemini has disappeared, the remainder is very bright.
- 9 40 The band of light has almost disappeared. Patches of light cloud moving from W. to N.
- 10 0 } No strict watch was kept, the sky being generally covered
 to } with cloud; but at each time of observation the north-
 12 0 } ern sky was illuminated with a bright light.

HALE WORTHAM, F.R.A.S., F.M.S., Royston.

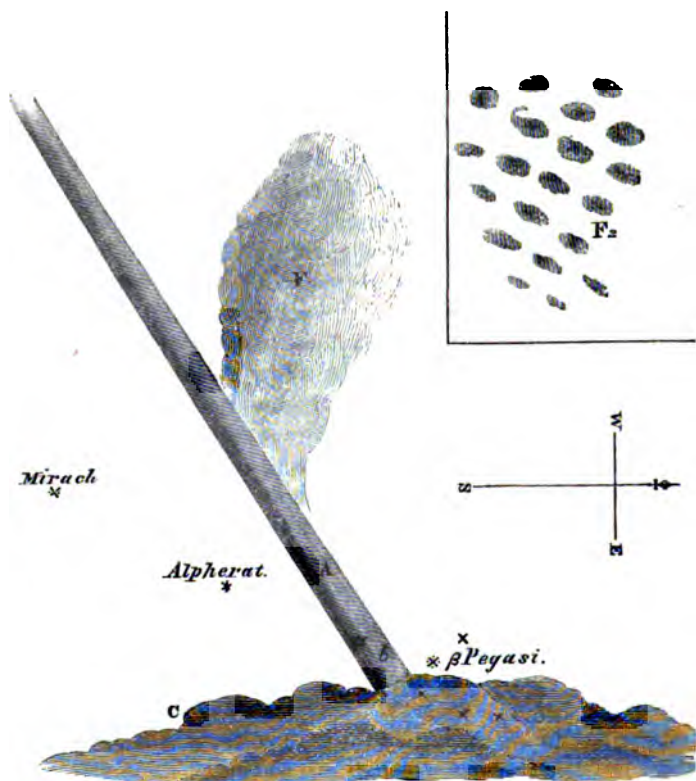
On this evening, at about $7^h 18^m$, an auroral display of an unusual character was observed here [the commencement, however, was evidently not seen]. The only noticeable object at first was a single beam like the tail of some enormous comet stretching upwards and southwards, at an angle of about 30° from the verti-

cal, from a small horizontal cloud near β Pegasi for a length of about 40° ; the brightest part of this beam was about 1° wide, but its northern edge was bounded by a paler beam of about twice the width of the brighter part; and at rather more than half the length of the beam, and from the northern side of the *paler* beam, diverged, at a considerable angle, a thin hazy expansion like a fox's brush. The direction of the main beam was nearly that of the zodiacal light; but its auroral character was shown by its gradual motion southward, drifting alternately over Alpherat, and β Andromedæ. The fox's brush was, however, soon left behind, ascended a little, and then resolved itself into six or seven parallel broken lines like a mackerel sky, and which at the upper part appeared mixed up with the Milky Way. Soon afterwards the beam disappeared; but the broken lines remained, and other mackerel-sky spots appeared at intervals so as almost to form a broken arch to the north-eastern horizon.

At its brightest and best, the beam and the fox's brush bore a singular resemblance to M. Pape's drawing of Donati's Comet on October 9, 1858, as given in 'Chamber's Handbook of Astronomy.' A few minutes after the disappearance of the before-mentioned beam, another fainter and smaller beam appeared nearly where the former one had been first seen, and at about $7^h 45^m$ a third beam, closely resembling the first in everything save the fox's brush, appeared at about the same spot. There was a faint auroral glow in the north during nearly the whole time; but, besides the beams before spoken of (and which were singularly persistent save as to their drifting southward), no noticeable streamers were seen. Soon after its first appearance, the first beam was noticed *below* the cloud from which it originally appeared to issue. A neighbour, whose residence is well situated for a view of the western heavens, says that the beam (the *first*, I assume) rose, at its beginning, from the horizon like a globe.

The notion of self-luminous clouds presented itself strongly to the mind throughout. The sky hazy and stars dim.

A sketch, from memory, of the first beam with its fox's brush is given on the next page. The smaller sketch in the corner shows the "fox's tail" as it broke up into cirro-cumulous patches.



A. The beam as first seen issuing from cloud C.

a. Its brighter side.

b. Its paler side.

F. The fox's brush.

F₂. The same brush as afterwards broken up into patches and left behind.

*The Magnetic Disturbances at the Royal Observatory, Greenwich,
on February 1, 1870.*

In the early part of the afternoon the magnets were in a fretful state, but no great changes occurred until after 5^h.

The first great movement commenced at 5^h 7^m when the western declination began to diminish, and by 5^h 27^m was 80 minutes less than at 5^h 7^m: this was followed by an increase to the same amount, but in a far shorter period of time (only 10 minutes), and then followed another decrease, amounting to 33 minutes, and occupy-

ing also about 10 minutes. At the same times (roughly speaking) corresponding changes occurred in the horizontal magnetic force, and also in the vertical magnetic force, although not to so great an amount. Active movements of small extent now followed, and the next movement of important magnitude occurred between 6^h 18^m and 6^h 40^m, when the declination magnet was drawn westward by 20 minutes.

Between 6^h 40^m and 8^h 20^m the movements, although active, were not large, the principal changes in declination being a decrease of 7 minutes between 7^h 12^m and 7^h 21^m, and an increase of 10 minutes from 7^h 21^m to 7^h 30^m. Between 8^h 20^m and 8^h 27^m the declination magnet moved to the east by 47 minutes, and in 10 minutes had moved back towards the west, through an arc of 37 minutes, then again to the east, to the amount of 19 minutes, by 9^h 3^m, and then swept westward through an arc of no less than 52 minutes by 9^h 45^m, this extreme change taking place at the time when the auroral band was observed spanning the zenith. Between 9^h 45^m and 10^h the magnet moved towards the east, through an arc of 41 minutes; then followed many other changes too numerous to mention, the magnet continuing in a state of active abnormal disturbance until about 3^h A.M. on February 2. The extreme values of the western declination during this disturbance were maximum 20° 17' about 9^h 45^m, and the minimum 19° 7' about 8^h 40^m, thus giving a range of 1° 10'.

The changes of the horizontal and vertical components of the magnetic force were very frequent and to considerable extent, the general result being a decrease of force in both cases. The earth-current trace shows considerable activity between the hours of 5^h and 6^h P.M., and also from 8^h 30^m to midnight, all disturbances ceasing by 3^h A.M. on the 2nd.

The Aurora of February 11, 1870.

G. L. SCHULTZ, Royal Observatory, Greenwich.

At 8^h 37^m P.M. auroral light visible: sky tinged with a fine blood-red colour in the N.E. 9^h P.M. Mr. Wright noticed that the clouds in the north were tinged with a deep-red colour.

OSMUND AIRY, Wellington College, Wokingham.

There was a most glorious aurora on Friday night, February 11, visible here. It was most brilliant at 8^h 45^m. There was a broad circular red band of light; but, appearing to radiate from the centre of the circle, underneath this was a band of very bright white light. The lowest point of the middle of the visible red arc was about 35° above the horizon. At 8^h 45^m the middle was slightly to the north of west; but gradually the whole band drifted away, and sunk beneath the horizon in the west. I never saw an aurora to compare with it. At 8^h 45^m the whole of the sky in the north seemed covered with rosy blood.

R. C. CANN-LIPPINCOTT, F.M.S., Over Court, near Bristol.

Aurora seen 8^h 30^m P.M. to 9^h P.M. The colour in the north was a deep rosy-aurora red, or deep rosy-red with a mixture of yellow.

The Aurora of February 12, appearing in DAYLIGHT.

The accounts of auroræ appearing by daylight are very few indeed, yet the following reports made by two of the observers in the magnetic department of the Royal Observatory, Greenwich, who called my attention to the appearance of the sky and to the fixity of the arch, as well as to the apparent avoidance by the clouds of the clear space, together with the disturbed state of the magnetic elements at the time, seem to decide that the appearances were really due to an aurora appearing by daylight.

Mr. Wright says that at about noon the clouds in the north began to break, and soon after an almost perfect arch of clear sky, with its apex in the magnetic meridian, was visible. This space of clear sky kept its shape more or less perfect for more than an hour—a remarkable fact, as the clouds in the remaining portion of the sky were being driven rapidly across by a strong N.E. wind. The clouds immediately above the top of the arch seemed to be charged with electricity, the edges assuming the ragged appearance common to thunder-clouds. At times these clouds were slightly tinged with a reddish colour. About 0^h 45^m P.M. a very remarkable cloud of a reddish-brown colour passed slowly across

the clear space from E. to W., being apparently much nearer to the observer than the ordinary clouds. Apart from the ordinary motion of the clouds from N.E. to S.W., caused by the wind, there seemed to be an apparent vibratory motion from E. to W.

Mr. Marriott says:—"About noon the clouds in the north began to break, and shortly after, there was a perfectly clear space of blue sky in the form of an arch, the apex of the arch being in the magnetic meridian. At the circumference of the arch were very fine cumulus clouds, the edges of which were tinged with a reddish colour; and along the whole of the north horizon there stretched a bank of cumulus clouds to the altitude of 10° or 15° . At about $0^h 20^m$, just below the apex of the arch, I observed something like steam shooting up and moving from east to west; this, I imagine, is what streamers would be like in the daytime. At $0^h 45^m$ a small cloud of a brick-red colour traversed the clear space; a few other clouds which passed over at the same time were not tinged. The arch was very well defined for about an hour or an hour and a half; and although the wind was blowing a gale from the north-east, and clouds passing rapidly over the other portions of the sky, this space was not encroached upon by clouds. The altitude of the arch was about 50° , and the point at which the supposed streamers first appeared was about 7° below the apex. I also observed auroral light at night.

"On the 11th day and till $6^h 35^m$ P.M. the movements of the several magnets were those of the ordinary diurnal changes, and at this time the western declination was $19^{\circ} 55'$. At $6^h 40^m$ a sudden disturbance began; the declination decreased $19'$ by $7^h 19^m$, then increased to $19^{\circ} 56'$ by 8^h ; at $8^h 12^m$ it was $19^{\circ} 47'$, increased to $20^{\circ} 4'$ by $8^h 29^m$, was $19^{\circ} 45'$ at $9^h 11^m$, was $20^{\circ} 6'$ by $9^h 58^m$ P.M., then there were several small movements of $3'$ or $4'$ both to the east and to the west; at $11^h 30^m$ the declination was $19^{\circ} 58'$, and by midnight had increased to $20^{\circ} 12'$.

"The magnet still continued to move through small arcs, but gradually decreasing to $4^h 10^m$ A.M. on the 12th to $19^{\circ} 47'$; then there were frequent changes of position, but such that the declination generally increased, and was $20^{\circ} 3'$ at $8^h 45^m$ A.M.; by $10^h 40^m$ it decreased to $19^{\circ} 55'$.

"There were frequent movements of the magnets between this time and till after noon. On the 12th day, at $0^h 30^m$ P.M., the declination was $20^{\circ} 12'$, at $0^h 45^m$ it was $20^{\circ} 3'$; this movement of the magnet towards the east is remarkable as having taken

place immediately preceding the passage of the reddish-coloured cloud from east to west across the clear space of sky, and attained its maximum at about the time of passage of the cloud. The movement of this cloud was not that of all other clouds, viz. from N.E. to S.W., and it would seem to have been of auroral origin.

"Between 0^h 45^m P.M. and 1^h, the west declination was increased by 7'. Between 1^h P.M. and 1^h 15^m P.M. the declination decreased by 10', and the magnet at 1^h 15^m was in the same position as at 0^h 45^m. From this time there were many small movements of the magnet east and west to the amount of 3', 4', 5', or 6'; but those of increasing western declination were somewhat larger than in the opposite direction; at 4^h P.M. the western declination was 20° 15', being about 15' greater than at 1^h 15^m. At 5^h 35^m the western declination had decreased to 19° 57', and the magnets were generally in a disturbed state till 5^h A.M. of the 18th. During the disturbance on the 12th the maximum western declination was about 20° 15', and minimum 19° 45', giving a range of about 30'.

"The movements of the horizontal-force and vertical-force magnets were similar and nearly to the same amounts. The earth-currents in the direction of north and south were also very much disturbed."

Authentic instances of auroral displays by daylight are very few.

The first instance I can find is recorded at p. 189, vol. ii. of the 'Transactions of the Royal Irish Academy,' from which the following extract is made:—

"An account of an Aurora Borealis seen in full Sunshine. By the Rev. Henry Ussher, D.D., F.R.S. and M.R.I.A.

"On Saturday night, May 24, 1788, there was a very bright aurora borealis, the coruscating rays of which united, as usual, in the pole of the dipping-needle. The next morning, about 11, finding the stars flutter much, I examined the state of the sky, and saw whitish rays ascending from every part of the horizon, all tending to the pole of the dipping-needle, where at their union they formed a small thin and white canopy, similar to the luminous one exhibited by an aurora in the night. These rays coruscated or shivered from the horizon to their point of union."

The only other account is extracted from the 5th vol. of the 'Transactions of the Royal Society of Edinburgh,' and is as follows:—

“An account of an Aurora Borealis observed in Daylight at Aberfoyle, in Perthshire, on the 10th of February, 1799. By Patrick Graham, D.D., Minister of Aberfoyle.

“On the 10th of February, 1799, about half an hour past 3 o'clock P.M., the sun being then a full hour above the horizon, and shining with an obscure lustre through a leaden-coloured atmosphere, I observed,” says Dr. Graham, “the rare phenomenon of an aurora borealis by daylight. The weather for several days before had been intensely cold, and during the two preceding days much snow had fallen. On this day a thaw had come on, and the temperature of the air was mild. The general aspect of the sky was serene. Some dark clouds hung on the horizon between S.W. and W. I was intensely observing a large halo about the sun, of about 20° in semidiameter. It exhibited the prismatic colours, though obscurely, except in one quarter, where it coincided with the skirt of a dark cloud on the horizon, almost directly west. In that portion of the halo, the colours of the iris were very distinctly exhibited.

“Whilst I was attending to this appearance, the whole visible hemisphere of the heavens became covered with a light palish vapour, as I at first imagined it to be. It was disposed in longitudinal streaks, extending from the west, by the zenith, and all along the sky towards the east. On examining this appearance more narrowly, I found it to be a true aurora borealis, with all the characters which distinguish that meteor when seen by night, excepting that it was now entirely pale and colourless. The stream of electric matter issued very perceptibly from the cloud in the west, on the skirts of which the halo exhibited the prismatic colours; thence diffusing themselves, the rays converged towards the zenith, and diverged again towards every quarter of the horizon; and the coruscations were equally instantaneous, and as distinctly perceptible as they are by night.

“This appearance continued for more than twenty minutes, when it gradually vanished, giving place to thin scattered vapours, which, towards sunset, began to overspread the sky. Through the ensuing night, I could not discern the smallest trace of these meteors in the sky.”

The Aurora of February 17.

Seen at Paris and Leipsic. The sky was overcast at Greenwich. At Greenwich till 6^h P.M. the magnets were moving with their

ordinary diurnal changes, and the only change of position on this day worthy of notice commenced at 6^h P.M., when the west declination was 19° 57'. It then decreased to 19° 58' at about 6^h 30^m, and then increased to 19° 57' again. During the remainder of the 17th, and throughout the next day, the magnets were entirely free from disturbance.

The Aurora of February 19.

On February 19 an aurora was seen at Stockholm. The sky was overcast at Greenwich; the magnets were slightly disturbed.

	^h	^m						
At	7	30	P.M.	the west declination was	19°	57'		
	8	0	"	"	"	"	19	45
	9	0	"	"	"	"	19	58

The Aurora of February 23.

On February 23 an aurora was seen at Stockholm and at Greenwich.

At Greenwich, Mr. Marriott reports that the sky was generally covered with cloud throughout the evening, and nothing remarkable was observed till about 9^h 15^m, when the sky in the north became very bright, and was of a reddish colour. A few minutes before 10, the clouds having broken up a little, I observed portions of two auroral arches, and a white patch of light in the magnetic meridian, about 20° above the horizon. The altitude of the upper arch was about 55°, and the lower one about 7° or 10° below.

And Mr. Schultz says that an appearance of aurora was observed on this night. Previous to, and a little after 9^h P.M. the sky in the north was generally dark and covered with clouds, with the exception of a small streak of light.

After 9^h 30^m the sky in the N.W. was conspicuously illuminated by a yellowish-red light. A few minutes after, two faint bands of light, slightly curved and forming an arch, became visible, the upper one being about 20° to the N.W. of the zenith, the lower one parallel to it. As the sky was partially covered with cloud, which appeared to shift about in a remarkably quick manner, the aurora was not observed any further.

From noon on this day to 9^h P.M. the west declination was gradually decreasing.

	h	m				
At 9	0	P.M.	the declination was ...	19	57	W.
9	20	"	"	19	45	
9	28	"	"	19	48	
9	40	"	"	19	38	
10	0	"	"	19	58	
10	15	"	"	19	40	
10	40	"	"	19	47	
11	0	"	"	19	47	
11	25	"	"	19	56	
Midnight		"	"	19	44	
0	20	A.M.	"	19	50	
0	40	"	"	19	43	
1	10	"	"	19	54	

CORRESPONDENCE, &c.

Results deduced from Thirty Years Observations (1840-69) at Burnham, Westgate, Norfolk. By H. E. BLYTHE, Esq.

The average mean annual temperature for—		°	
Ten years ending 1849		48.1	
Maxima 1840, 1848	49.33		
Minimum 1844.....	46.2		
Ten years ending 1859		47.73	
Maximum 1857.....	49.94		
Minimum 1855.....	44.7		
Ten years ending 1869		47.97	
Maximum 1868.....	50.33		
Minimum 1860.....	45.1		
Thirty years ending 1869		47.933	
The average annual rainfall for—		ins.	ins.
Ten years ending 1849		30.72	
Maxima 1841 and 1848	37.6		
Minimum 1844.....	25.37		
Ten years ending 1859		26.859	
Maximum 1852	33.33		
Minimum 1858	23.40		
Ten years ending 1869		26.16	
Maximum 1860	34.65		
Minimum 1864.....	17.68		
Thirty years ending 1869.....		27.913	

Abstract derived from Meteorological Observations made at certain Stations in the Colony of the Cape of Good Hope (compiled by a Commission appointed by Government).*

TABLE I. Abstract derived from Meteorological Observations made at the Royal Observatory, Cape of Good Hope, in the Years 1862, 1863, 1864, 1865, 1866, and 1867.

Months.	Mean Height of Barometer at Temperature 32°.	Temperature of the Air.				Mean Temperature of Evaporation for each Month.	Mean Humidity for each Month.	Rain. Inches.	Clouded Sky. Per cent. of visible Hemisphere.	Lightning. Recorded Number of Days.
		Mean Daily Range.	Mean of Greatest Range on any one Day of each Month.	Mean of Least Range on any one Day of each Month.	Mean of Greatest Range throughout each Month.					
January	inches. 29.930	16.97	30.80	9.42	37.28	62.66	62.62	0.282	26	4
February	71.03	15.74	29.35	8.63	34.27	62.32	65.61	0.870	33	7
March	69.87	16.30	30.50	7.60	39.35	60.80	67.79	0.868	31	16
April	67.74	14.40	27.90	6.75	36.20	57.51	73.06	1.717	45	10
May	62.78	13.56	25.25	4.57	33.75	55.16	77.42	2.841	46	9
June	59.31	11.56	22.95	4.49	30.67	52.51	79.84	4.748	52	6
July	55.89	11.81	20.75	3.47	27.54	52.07	79.64	3.828	48	9
August	55.29	11.52	23.37	4.24	32.25	52.45	78.32	2.369	48	4
September	56.07	12.76	26.20	5.20	33.97	53.23	73.88	1.579	44	13
October	57.93	13.41	27.57	5.99	35.57	52.35	73.31	2.725	52	7
November	60.75	15.14	25.59	8.32	34.59	57.61	67.81	0.780	40	4
December	63.99	15.90	29.67	9.49	37.97	61.44	64.77	0.288	32	6
Mean annual values.....	62.47	14.09	26.65	6.51	34.45	56.68	72.01	22.895	42	16

1862. } Highest { Dec. 24, = 94.0 } 1866. } Highest { Mar. 26, = 94.5 } 1862. } Lowest { May 29, = 41.3 } 1866. } Lowest { June 22, = 40.0 }
 1863. } temp. { Jan. 14, = 92.5 } 1867. } temp. { Jan. 3, = 97.8 } 1863. } temp. { June 27, = 40.0 } 1867. } temp. { June 16, = 41.0 }
 1864. } Greatest range on } Dec. } = 37.2 } 1864. } Greatest range on } Dec. } = 39.8 } 1863. } Least, 1863 } July 15, = 1.3 }
 1865. } Dec. 6, = 96.0 } any one day, 1862 } 24 } 1865. } any one day, 1862 } 24 } 1865. } May 27, = 42.2 }

* *Members of the Commission*—
 Hon. RICHARD SOUTHEY Colonial Secretary (Pres.). | CHARLES D. BELL, Esq., Surveyor-General. | WILLIAM MANN, Esq., Asst.-Astronomer.
 Sir THOMAS MACLELLAN, Kt., H.M. Astronomer. | EDGAR L. LAYARD, Esq., Curator of the | G.W.H. MACLELLAN, Esq., 2nd Asst.-Astron.
 Royal. | MUSEUM.

TABLE II. Abstract of the Mean Annual Meteorological Results from the following Stations, Cape of Good Hope

Names of Stations.	Names of Observers.	Mean Height of the Barometer, 32° Fahr., reduced to Temperature 59° Fahr., and to the Observatory standard.	Temperatures, Fahr.				Mean Annual Humidity at 9 A.M., 1 and 3 P.M.	Mean Annual Falls of Rain.	Mean Annual Clouded Sky; per cent. of visible Hemisphere.	Mean Annual Number of Lightning or Thunderstorms.	Approximate Heights of the Stations above the Sea-level.	Years of Observation from which the results are derived.
			Mean Annual.	Mean of Greatest Day.	Mean of Least Range on any one Day.	Mean of Greatest Range of each Month.	Mean Annual Temperature at 9 A.M., 1 and 3 P.M.					
Graaff-Reinet....	Prof. Guthrie, and J. Akin-son, Esq.	27.508	64.41	24.52	37.88	11.58	48.74	58.17	55.98	13.196	36	1863-65.
Worcester	J. D. Hugo, Esq.	29.238	62.75	24.89	40.98	10.15	48.82	57.88	54.63	11.745	31	1862-66.
Mossel Bay	H. W. Lavis, Esq.	29.608	61.90	17.78	27.42	9.00	38.25	59.20	69.47	11.550	41	1862.
Somerset West	Alexander Graf, M.D.	29.931	61.89	20.88	35.08	8.12	42.87	59.93	68.83	26.671	33	1862-63.
Simon's Town	Dr. Churehill	30.023	65.14	15.00	23.98	6.50	30.91	62.27	79.17	29.489	52	1862-65.
Royal Observa- tory.	Personal Establishment.	30.028	62.47	14.99	26.65	6.51	34.45	56.68	72.01	23.895	42	1862-67.
Graham's Town	Royal Engineers*	30.026	62.65	18.59	.....	.....	43.94	58.90	70.30	32.594	...	1855-59.
Maritzburg	J. R. Mann, M.D., F.R.A.S.†	27.896	64.83	.....	.....	.....	41.86	.....	70.80	30.230	51	1856-65.
Adelaide	Charles Todd, Esq., F.R.A.S.	29.897	63.94	20.98	33.97	11.58	45.91	55.82	58.25	20.505	48	1858-63.
Hobart Town	†	29.876	64.90	20.36	33.83	11.57	45.00	56.30	58.00	22.763	49	1862-63.
St. Helena	F. Abbott, Esq.	29.894	56.20	18.48	32.50	9.00	.....	50.86	72.17	25.710	58	1859 & '64.
Antananarivo	Royal Artillery	28.285	61.40	.....	.....	.....	.....	59.00	87.00	47.198	...	1864.
New Zealand	Mr. Cameron §	25.606	55.3	.....	.....	.....	.....	.....	64.69	38.710	66	1864.
	||	30.610	55.3	Mean of greatest range for year.	.....	.....	50.3	51.4	77.0	44.88	27	1864.

* Graham's Town.—“Abstracts of Meteorological Observations taken at the Stations of the Royal Engineers,” published in 1862. The barometer is reduced to the sea-level. The several means are derived from five years' observations. Lat. 33° 18' 30", long. 8° 0' east of the Cape Observatory.

† Maritzburg.—Lat. 29° 38' S., long. 11° 33' east of the Cape Observatory. Means of nine years' observations, ending 1866, inclusive.

† Meteorological Observations, by Charles Todd, Esq., F.R.A.S. Lat. 34° 57' S., long. 129° 9' east of the Cape Observatory.

§ Greatest fall of rain in one day, 3.18 inches. Number of rainy days, 57. Mean of greatest range of barometer, 0.285 inch.

|| Meteorological Observations, by Charles Rous Martin, Esq. Mean of nine stations—Mantdale (lat. 46° 17' S., long. 180° east of the Cape Observatory), Mongonui, Auckland, Taranaki, Napier, Wellington, Nelson, Christchurch, Dunedin.

TABLE III. Rainfall (in inches) at several Stations in the Colony, Cape of Good Hope.

	Dr. Guthrie. (Mr. Atkinson and Gruaff-Reinet.	Worcester (J. D. Hugo).	Mossel Bay (Captain Lays).	Gouernet West (Dr. Graf).	Simon's Town (Dr. Churchill).	Observatory.	Sea Point (Mr. Steyn).	Rhenosterfontein (Dr. White).	Stellenbosch (Dr. Verneid).	Lower Nel's Port (Mr. Jackson).	Namagualand (Mr. Fletcher).	Gruaff's Kraal, (undertain).	Concordia, (Mr. Von Seelicht).	Wynberg (Mr. Blore).	Cape Town (Municipality).	Groote Poete.	Port Elizabeth.	Alwal North (Mr. Downing).	Wendland, (Gruaff-Reinet).
1862	.....	21.235	11.550	28.707	36.090	32.008	27.551	.....	23.460	.....	.....	.....	13.600	68.500	28.750	.....	.....	.....	.....
1863	.....	16.521	14.551	24.634	33.040	25.603	23.445	.....	23.460	.....	8.400	16.980	.....	.....	26.000	.....	.....	.....	.....
1864	.....	14.010	8.769	.....	23.090	18.915	18.071	.....	21.860	.....	12.060	14.370	.....	.....	34.226	.....	.....	.....	.....
1865	.....	9.055	5.330	.....	44.820	18.668	16.201	8.300	24.225	10.610	5.730	6.180	6.040	36.573	.....	.....	.....	.....	.....
1866	.....	0.688	.....	.....	.....	19.207	20.263	.....	.....	9.060	8.660	.....	9.658	33.573	.....	22.469	.....	.....	.....
1867	.....	18.206	.....	.....	.....	22.965	20.307	.....	.....	.....	.....	17.000	.....	29.325	.....	16.011	33.650	18.910	9.420
Means	14.448	11.745	11.550	26.670	29.485	22.895	20.972	8.300	23.181	10.577	8.103	13.648	9.766	40.439	24.457	19.240	33.650	18.910	9.420
1868.	1.187	0.067	0.080	0.356	0.697	0.282	0.268	0.590	0.437	1.327	0.050	0.868	0.020	0.311	0.177	1.450	0.470	1.550	0.210
January	2.618	1.133	0.570	0.742	0.470	0.870	0.983	0.530	0.540	2.353	0.678	2.147	0.193	1.007	0.220	2.020	1.370	2.500	1.815
February	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
March	1.193	0.223	1.190	1.332	1.403	0.868	0.590	0.190	0.610	1.987	0.190	1.447	0.398	0.628	1.230	0.670	1.710	2.310	0.820
April	0.964	0.443	1.090	1.438	1.957	1.717	1.407	0.700	1.970	1.830	0.389	1.315	0.593	1.573	1.427	1.353	1.310	1.060	0.640
May	0.978	1.305	0.800	2.475	3.395	2.841	2.688	0.790	4.240	0.234	0.523	0.812	1.346	3.574	3.053	0.907	2.740	0.620	0.935
June	0.319	2.218	1.110	5.727	5.103	4.748	4.419	0.130	3.303	0.030	2.158	0.103	1.949	9.350	6.227	3.468	4.600	1.350	0.160
July	0.405	1.632	2.520	4.299	5.282	3.828	3.356	0.480	3.303	0.487	1.018	0.445	1.538	8.359	3.017	3.046	1.920	0.000	0.200
August	1.074	1.564	2.020	3.395	2.830	2.369	2.260	0.330	2.513	0.557	1.083	1.205	2.430	6.399	3.307	2.359	3.100	0.650	1.365
September	0.941	1.272	0.770	2.456	2.753	1.579	1.537	0.210	1.890	0.953	0.529	0.405	0.860	3.171	1.807	1.157	3.910	0.650	0.165
October	1.549	1.264	0.880	2.999	4.002	2.791	2.505	1.610	2.673	0.263	1.178	1.468	0.147	4.502	3.212	2.095	2.650	1.350	0.950
November	1.903	0.560	0.370	0.962	1.353	0.780	0.613	0.560	1.308	0.333	0.175	1.798	0.209	1.286	0.687	0.353	9.150	2.380	1.580
December.	1.318	0.044	0.150	0.479	0.240	0.288	0.346	0.380	0.367	0.223	0.132	1.575	0.083	0.279	0.093	0.362	0.720	4.490	0.580
Mean	14.449	11.745	11.550	26.670	29.485	22.895	20.972	8.300	23.181	10.577	8.103	13.648	9.766	40.439	24.457	19.240	33.650	18.910	9.420
Annual	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Fall	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

N.B. 1868.—*Graham's Town*, from January 1 to November 9, 18.120 inches. *Alwal North*, from March 7 to December 31, 12.750 inches. *Bredandorp*, from May 1 to December 31, 8.770 inches.

Port Elizabeth, from May 1 to December 31, 7.840 inches. 1867.—*Amalienstein*, from February 1 to December 31, 30.900 inches.

DIAGRAM 1.
SHOWING THE DAILY AMOUNT OF RAINFALL ON EACH
DAY OF A LUNATION.

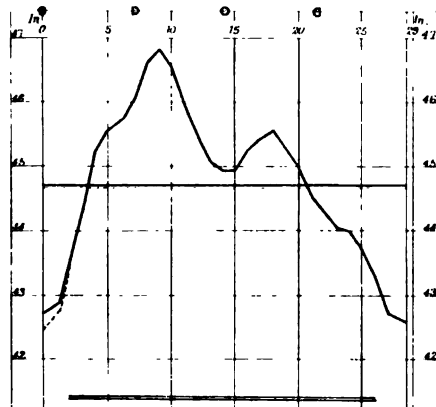


DIAGRAM 2
SHOWING THE LENGTH OF TIME THE MOON IS ABOVE THE
HORIZON ON EACH DAY OF A LUNATION.

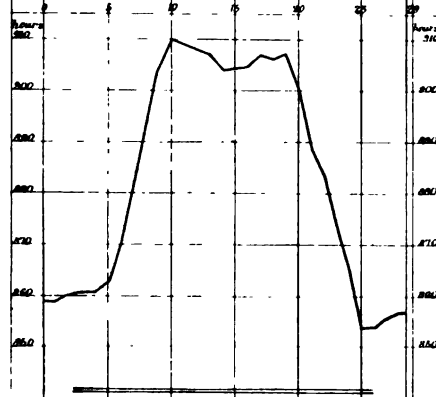
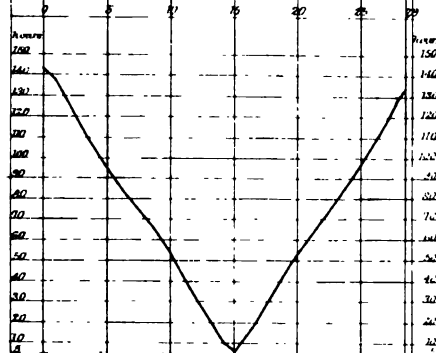


DIAGRAM 3
SHOWING THE LENGTH OF TIME THE SUN AND MOON ARE TOGETHER
ABOVE THE HORIZON ON EACH DAY OF A LUNATION.



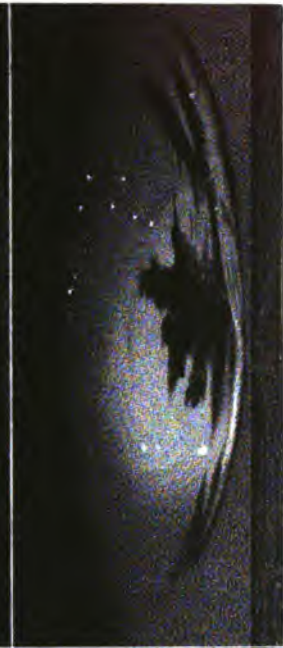
Nº 2.



Nº 4.



Nº 6.



Nº 1.

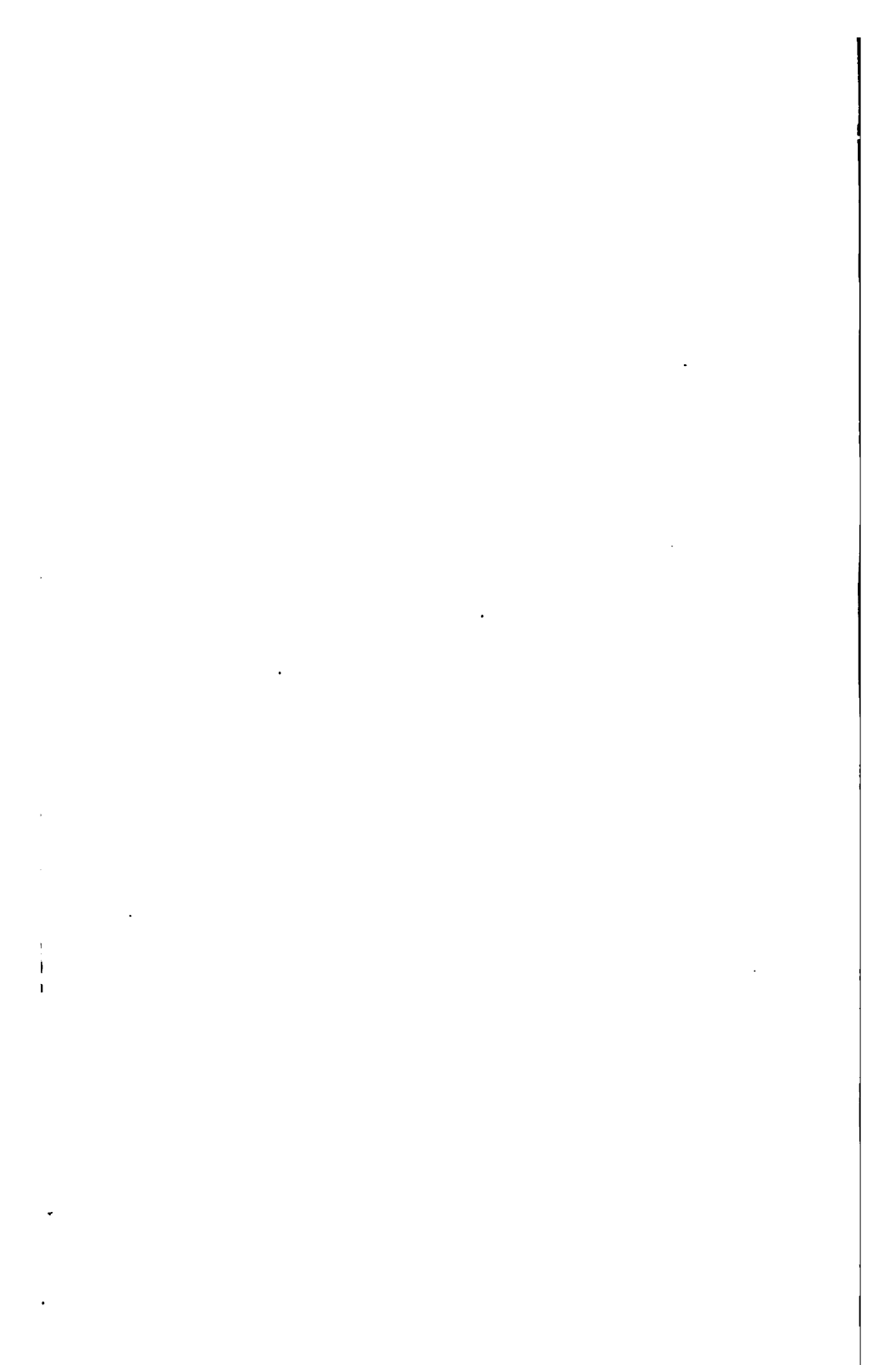


Nº 3.



Nº 5.







ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	<i>£</i>	<i>s.</i>	<i>d.</i>		<i>£</i>	<i>s.</i>	<i>d.</i>
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line	0	0	3	Bills, half-sheet and less	1	10	0
Half a page	0	17	6	„ whole sheet	2	10	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

SESSION 1869-70,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., at 7 P.M.

1869, November	17	1870, March	18
1870, January	19	„ April	20
„ February	16	„ June (ANNUAL)	15

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 6s. Vol. IV. £1 6s.

Cases for binding (price 1s. 3d. each) may also be had of the Undertakers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 13, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different forms of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

“Those who desire correct information on the best means of observing meteorological phenomena, will find what they require in Mr. Belville's Books.” —*ATHENÆUM*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Senate Society, &c., Red Lion Court, Fleet Street, E.C.

[Price Two Shillings.]

Vol. V.]

[No. 48.]

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1870, MARCH 16.

CONTENTS.

Communication made at the Ordinary Meeting:—

	Page
III. On the Fall of Rain on Every Day of the Year, from observations extending from 1813 to 1869,—James Glaisher, F.R.S.	27

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, May.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1870, MARCH 16. [No. 48.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Cook, Henry, M.D., F.R.G.S., F.G.S., *Ringmore, near Teignmouth,
Devon*;

Fielding, George H., M.D., *Tunbridge, Kent*;

Swete, Horace, M.D., *Dunmarklyn, Weston-super-Mare*;
were balloted for and duly elected Fellows of the Society.

The names of Five Candidates for admission into the Society
were read.

XII. *On the Fall of Rain on Every Day of the Year, from obser-
vations extending from 1815 to 1869.* By JAMES GLAISHER,
F.R.S.

THE record of rainfall for fifty-five years held out the hope that the day-by-day causes of rainfall, such as varying direction of wind, the meeting of currents of air of different temperatures, &c. might in so long a period be somewhat equally balanced, and that consequently the annual march of the fall of rain throughout the year might be pretty well determined by simply collecting all the falls of rain which had taken place in the several years on the same day of the year.

TABLE I. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1815.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1816.	...	...	...	...	...	...	...	08	...	02	...	...	...	21	...
1817.	10	25	60	34	21	43	05	18	07	17	18	...	12	...	07
1818.	...	05	...	...	22	30	...	08	...	07	02	...	07	03	20
1819.	...	...	...	...	...	...	...	21	11	41	10	07	...	06	01
1820.	...	...	13	...	...	...	...	...	...	...	36	18	08	10	...
1821.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1822.	11	...	...	21	...	...	...	...	...	...	...	...	...	...	...
1823.	...	...	...	...	26	...	...	...	...	...	...	...	...	...	...
1824.	26	...	04	...	...	...	...	...	...	...	...	...	...	...	...
1825.	...	05	...	18	02	...	...	...	...	...	...	...	...	...	...
1826.	...	09	...	...	...	10	05	...	...	...	...	...	...	...	...
1827.	...	27	...	...	...	...	...	...	...	...	42	08	...	...	...
1828.	24	42	21	...	27	35	...	...	...	...	...	30	...	68	31
1829.	...	...	...	31	05	...	...	...	...	...	...	...	...	...	...
1830.	...	...	15	09	13	...	...	...	...	...	...	...	...	...	66
1831.	01	...	...	...	01	...	...	...	06	01	...	01	...	...	...
1832.	...	...	...	...	...	...	06	...	04	05	09	36	10	...	...
1833.	09	14	01	...	...	...	...	...	...	...	...	04	...	...	...
1834.	...	01	01	04	01	25	09	30	16	08	23	11	19	22	18
1835.	...	...	...	...	...	...	...	05	13	03	...	...	...	...	15
1836.	...	15	01	...	01	04	...	...	...	...	66	...	...	81	...
1837.	...	...	...	...	...	...	...	...	...	35	...	...	20	...	...
1838.	05	13	...	...	...	06	...	...	...	...	...	...	...	...	...
1839.	04	...	...	...	06	13	...	...	...	...	...	...	...	...	...
1840.	...	...	...	27	...	...	...	...	...	...	...	...	...	...	10
1841.	...	...	...	...	25	...	...	...	...	...	17	...	37	43	13
1842.	...	...	...	...	...	...	...	...	07	01	...	...	19	...	...
1843.	...	...	...	01	...	...	08	15	...	14	...	...	45	...	16
1844.	31	...	20	...	39	...	...	05	...	...	76	25	...	...	...
1845.	...	01	08	...	...	...	...	...	01	48	05	09	...	...	...
1846.	...	...	02	...	01	06	...	...	...	...	...	...	...	...	...
1847.	...	...	08	05	...	...	...	...	...	...	01	...	...	...	...
1848.	...	...	...	...	...	...	22	01	...	...	...	...	03	06	...
1849.	...	...	...	03	21	...	10	13	07	05	05	...	08	06	...
1850.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1851.	01	...	34	...	...	...	01	03	...	28	...	...	...	...	...
1852.	...	...	02	...	...	...	...	...	12	...	20	23	91	01	31
1853.	...	03	14	04	04	24	22	...	...	11	06	06	09	...	13
1854.	...	...	...	...	60	09	52	04	...	05	01	...	03	03	...

Day in JANUARY during the Years from 1815 to 1869.

the Month.																Sums.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
...	'02	...	...	...	...	...	...	...	...	...	...	'26	'05	'01	'13	0'78
'14	'39	...	'02	'02	'09	'16	...	'02	...	...	'19	'01	...	...	...	1'90
'05	'30	'10	...	'06	...	'07	...	...	'01	...	...	'04	...	...	...	2'85
...	...	...	...	...	'04	...	'03	...	...	...	'23	'20	...	'32	...	1'73
'06	...	'15	...	'13	'10	...	'08	...	'09	'21	'02	'01	...	'30	...	2'12
...	...	...	...	'13	...	...	...	...	...	'27	...	'15	...	...	'05	1'73
'36	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'10	2'18
...	...	...	...	...	...	...	...	'20	...	'03	...	...	...	...	...	0'55
...	...	...	...	...	...	...	...	...	...	...	...	...	1'07	'03	...	1'36
...	...	...	...	...	...	...	...	...	...	...	...	'04	...	...	...	0'94
...	...	'36	...	...	'07	...	...	'14	'15	...	'06	...	...	...	...	1'03
...	...	...	...	...	...	...	...	'06	...	...	...	...	...	...	...	0'30
...	'12	...	...	...	...	...	...	...	...	...	...	...	...	...	'17	1'06
'67	'29	'10	...	...	...	...	...	...	...	'03	...	...	...	...	...	3'87
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'36
...	...	...	'75	'13	'13	...	'16	...	...	...	'18	'11	'11	...	'03	2'63
'06	...	'13	'03	'90	'19	'37	'19	...	...	'29	...	...	...	...	'49	2'75
...	...	...	...	...	...	...	...	'23	...	'20	'13	'03	...	...	...	1'29
'04	'06	...	...	...	...	...	...	...	...	...	...	'15	'01	...	'23	0'77
'65	'19	'01	...	...	'05	'33	'02	'05	'07	'07	'10	'11	...	'01	...	3'54
'15	...	'15	...	'13	'10	...	...	...	...	...	...	...	...	...	...	0'89
...	...	...	...	'01	...	'10	'09	'01	...	...	...	'06	'44	'14	'31	2'84
...	...	...	...	...	...	...	'42	...	...	1'10	'07	...	...	...	'28	2'42
'22	...	'23	...	...	...	...	...	...	...	...	...	...	'05	'05	...	0'79
...	'11	...	'12	...	'28	'20	...	...	...	...	...	...	'18	'10	...	1'22
...	...	...	'25	'28	'09	...	'08	'26	...	'37	...	'40	'06	...	...	2'16
'12	'03	'29	...	...	...	'10	...	...	...	...	...	...	...	'12	...	2'01
...	...	...	...	...	...	...	...	'15	'03	'10	...	...	...	...	'20	0'75
...	...	...	...	...	...	...	...	'02	...	...	...	...	...	...	'03	1'04
...	...	...	...	...	...	...	...	...	...	...	'02	...	...	'01	...	1'99
...	...	'25	...	...	...	...	...	...	'04	'13	'13	'07	...	'10	...	1'44
'04	...	'21	'28	'06	'27	'06	'25	'26	'60	'17	'01	'10	...	'08	...	2'48
...	...	...	...	'03	'34	...	'03	'07	'04	...	'07	...	...	...	...	0'72
...	'28	...	...	...	...	...	...	...	'03	...	...	'02	'04	'06	'21	0'96
'01	'18	...	...	...	'10	...	...	...	'06	'01	'40	'05	...	'02	...	1'61
'05	...	'18	'31	...	'12	...	...	...	'20	...	'01	'16	'09	'05	...	1'17
'10	'13	'32	...	'14	'31	'01	...	...	...	...	'10	'05	'48	'12	'43	2'43
...	'10	...	'07	'01	'25	...	'11	'05	...	'24	...	...	'14	'11	'28	2'88
'30	'03	...	'01	'08	'17	...	...	...	...	'01	'06	...	'06	'07	...	1'95
'06	'01	...	'01	...	'01	'02	'10	...	...	...	...	'09	...	...	...	1'67
'11	'02	'05	...	...	'04	'03	'11	'16	'04	'06	'02	'05	...	...	...	0'99
'06	'01	'03	'05	'16	'32	'20	...	'06	'10	'23	...	'15	'01	...	...	2'36
...	'01	...	'02	'24	...	'02	'03	'10	'16	'02	'01	...	...	...	'25	2'59
...	...	...	...	...	...	...	...	...	...	...	...	...	...	'26	'25	0'76
...	...	'08	...	...	'04	'25	...	...	'10	...	...	'01	'16	...	...	0'79
'07	'03	'01	'05	'31	'04	...	'01	'10	'04	'15	'10	...	'09	'21	'01	1'66
...	'01	...	'01	...	...	'05	...	...	'03	...	...	...	...	...	'01	0'51
...	...	...	...	'07	'03	'11	...	'41	...	...	'02	'03	'41	'02	'17	1'79
...	...	'28	...	...	'03	'01	...	...	'08	...	...	...	...	...	'52	2'72
...	'22	...	'01	'15	'06	...	'04	'19	...	'03	'01	...	...	...	...	0'88
...	'03	...	...	...	...	...	...	'04	'04	'20	1'25	...	'17	'20	'32	3'32
'25	'03	...	'02	'13	...	'23	...	...	...	...	'01	...	...	...	'11	3'68
'01	'01	'08	...	...	'02	'08	'01	'02	'21	...	'01	...	'43	...	...	2'79
...	'11	'34	'36	...	'08	1'21	...	'06	'32	...	'43	'06	...	...	...	4'19
...	'12	'01	...	...	...	...	...	...	...	'03	'23	'70	'06	'21	...	2'92

TABLE II. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	'06	'05	'01	'09	...	...	'01	...	'10	'01	'02	'12	'23	...	'07
1816.	...	...	'17	'04	'02	'29	...	'58	...	...	...	...	...	...	...
1817.	...	...	...	...	'01	'02	...	...	'01	...	'20	'14	'05	'14	'17
1818.	...	'26	...	...	...	...	...	...	...	...	...	'06	...	...	...
1819.	'14	'16	...	'06	'10	'10	'26	...	'11	'20	...	...	'15	'09	...
1820.	...	...	...	...	...	'03	...	...	...	...	'10	'20	'40	'21	40
1821.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1822.	...	...	'30	...	'08	...	...	'29	'03	'01	...	'11	...	...	...
1823.	'23	...	'33	'20	...	...	...	'44	'19	'25	'08	'15	...	...	...
1824.	...	...	...	'09	'11	...	...	...	'11	...	...	...	...	'18	...
1825.	...	'08	...	...	...	...	...	'40	...	...	...	...	...	...	...
1826.	...	'05	...	'07	...	'14	...	...	...	...	...	...	...	'10	...
1827.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1828.	'14	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1829.	...	...	...	'20	'14	...	...	...	...	...	...	...	...	'15	...
1830.	'03	...	...	...	...	...	'32	'66	'04	...	...	...	...	...	...
1831.	...	...	...	...	...	...	2'89	'03	...	...	'03	'06	'05	...	'02
1832.	'10	...	...	...	'25	...	...	'13	...	...	...	...	...	...	...
1833.	'55	'05	'04	...	...	'10	'01	'61	'46	'21	'22	'29	'37	'82	...
1834.	...	...	...	'01	'25	...	...	...	...	'13	'12	'03	...	...	...
1835.	'06	...	...	...	'03	...	'02	'08	...	'04	'04	'25	...	...	...
1836.	...	'88	'29	'08	...	...	'21	...	'03	...	...	...	'17	...	...
1837.	...	...	...	...	...	...	...	...	...	...	'30	'20	...	'05	...
1838.	...	...	...	...	...	...	'10	...	'12	...	...	...	...	...	...
1839.	...	...	'22	'08	'35	'02	...	...	...	'06	...	'06	...	...	...
1840.	'15	...	...	'13	'30	'10	...	...	...	'15	...	...	'06	...	'15
1841.	...	...	...	...	...	...	...	...	...	...	'10	'02	...	...	'07
1842.	...	...	...	...	...	'02	'02	'04	...	...	'06	...	'03	...	...
1843.	...	'03	'30	'01	...	...	...	'50	'02	'06	...	...	...	...	...
1844.	...	'19	...	...	...	'17	'11	...	'33	...	...	...	...	...	'01
1845.	...	'07	...	...	...	...	...	...	...	...	...	...	...	...	...
1846.	'70	...	...	'35	...	...	'06	...	...	...	...	...	'25	...	...
1847.	...	...	'07	...	'03	...	...	'37	...	...	...	...	'22	'15	'26
1848.	...	...	...	...	'10	'04	'30	...	...	'40	'12	...	...	'03	'04
1849.	'01	'02	'02	...	...	...	...	'06	...	...	...	...	...	...	...
1850.	'24	'01	...	...	'20	...	...	'03	'09	...	'10	'06	...	'15	'05
1851.	...	'16	'05	'01	'07	'08	'02	...	...	...	...	...	'05	'01	...
1852.	...	'03	...	'14	'14	'01	...	'12	'07	'03	...	...	...	...	...
1853.	...	'01	...	'06	...	...	...	...	...	'05	'01	...	'20	'05	...
1854.	'38	...	'04	'05	'13	...	...	...	'12	...	...	...	...	...	'13
1855.	'16	...	'05	'15	'05	...	'05	'48	...	...	...	...	...	...	...
1856.	...	...	...	'02	'03	...	...	'14	...	...	'23	'05	'17	'10	...
1857.	...	...	'08	...	...	...	...	...	...	'08	'01	...	...	...	...
1858.	...	'30	...	'47	...	...	...	...	...	...	...	'01	'07	'81	'06
1859.	...	'09	...	'12	'03	'20	'03	'01	'14	'04	'02	...	...	'04	...
1860.	...	...	'01	...	...	'31	'01	...	'06	...	'01	...	'02	...	'01
1861.	...	...	...	...	...	...	'01	'01	'11	...	'03	...	'04	'05	'10
1862.	'05	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1863.	'01	'07	'09	'01	'02	...	...	'08	...	...	...	'04	...	...	...
1864.	...	...	'03	...	'03	...	...	'01	...	...	...	'01	...	...	...
1865.	'03	'02	...	'01	'01	'12	'08	'09	...	...	'08	...	...	...	...
1866.	'07	'33	'17	'34	...	...	'09	...	'26	'21	'72	'10	...	'09	...
1867.	'09	...	...	'08	'07	'08	'18	'01	'06	...	'24	...	...	...	'02
1868.	'02	'25	...	...	...	...	'02	'09	...	...	...	...	...	...	'02
1869.	'32	'01	'07	'04	...	...	...	'02	'09	...	'10	'77	...	...	'04

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

91

Day in FEBRUARY during the Years from 1815 to 1869.

the Month.															Sums.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	Sums.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.	
'03	'12	'08	...	'02	'16	...	...	...	...	...	'02	...	...	1'20	
'04	...	...	'08	...	...	...	...	...	...	'15	'10	...	...	1'47	
...	'05	'03	'02	...	'05	'05	'01	...	'05	'08	'07	'04	...	1'19	
'08	...	'02	'11	'15	...	'22	'40	'11	'10	'08	'22	...	...	1'81	
'02	...	'16	'13	...	'20	'11	'46	'02	...	'10	'08	'02	...	2'67	
...	...	...	...	...	...	...	'08	'06	'35	'11	...	...	...	1'94	
...	...	...	...	...	'04	...	...	...	...	...	...	...	...	0'04	
'03	...	...	...	'01	'10	...	...	...	...	...	'02	...	...	0'98	
...	'16	...	'25	'01	...	'25	...	'48	...	'12	'03	...	...	3'17	
...	...	...	...	'25	'15	...	...	'15	...	...	...	'21	'09	2'34	
...	...	'19	...	...	...	...	...	...	...	...	'11	'08	...	0'86	
...	'35	'12	...	'10	'12	'17	'15	...	'26	...	...	'03	...	1'66	
...	...	...	...	...	...	...	...	...	...	...	...	'60	...	0'60	
...	...	...	...	'70	...	'05	...	...	'04	...	...	...	'11	1'04	
...	...	...	...	...	'13	...	...	...	...	...	'55	...	...	1'17	
...	...	'01	...	...	'66	'38	'05	...	'14	'08	...	...	...	2'37	
'07	...	...	'10	...	'04	'01	'03	'06	'14	'19	'19	...	...	3'91	
...	...	...	...	...	...	...	...	'23	...	'20	'13	'03	...	1'07	
...	'24	...	'41	'46	...	...	'02	'15	'28	'17	'14	'10	...	5'70	
...	...	...	'10	...	...	'01	'01	'06	...	...	'03	'06	...	0'81	
...	'03	'18	'63	'40	...	'58	...	...	'43	'22	'01	'40	...	3'40	
...	...	...	...	...	...	...	...	...	...	'70	...	'05	'10	2'51	
...	...	'18	'57	...	'07	...	...	...	...	...	...	'15	...	1'52	
...	'29	...	...	...	'03	...	'45	'22	...	'50	'10	...	...	1'81	
'15	'06	...	...	...	...	'16	'18	...	'02	...	'03	'02	...	1'41	
'05	...	...	...	...	...	...	...	...	...	...	...	...	...	1'09	
'14	...	'09	...	'10	'01	...	...	...	'07	'14	'03	...	...	0'77	
...	...	...	...	...	'14	...	'06	'06	...	'04	'18	'04	...	0'69	
...	...	...	...	'35	'08	'10	...	'02	...	'58	'03	'12	...	2'20	
'01	...	'03	'05	...	'08	...	'39	...	'25	'05	'05	'05	'11	1'88	
...	...	...	...	...	...	...	'25	...	'20	...	...	...	...	0'77	
...	...	...	...	...	...	'19	'05	'08	...	...	'02	...	...	1'45	
'15	...	'01	...	...	...	...	...	...	...	...	...	...	...	1'26	
...	...	...	'12	'10	'07	'11	...	'02	'14	'30	'35	'03	'20	2'47	
...	...	...	...	'40	'02	...	...	'25	'20	'40	...	'78	...	2'16	
'17	...	...	...	'19	...	...	...	...	...	...	...	...	...	1'29	
...	...	...	...	'20	'10	...	...	'03	...	...	'08	...	...	0'86	
'03	...	...	...	...	...	...	...	...	...	'01	...	'15	...	0'73	
'05	...	'03	...	...	...	'10	'02	'05	'10	'12	...	...	...	0'85	
...	'08	...	...	...	...	...	'10	...	...	...	...	...	...	1'03	
...	...	...	...	...	...	...	'10	...	'16	'05	'12	'01	...	1'38	
...	...	'01	'10	...	'08	...	...	...	...	...	...	...	...	0'93	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'17	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1'72	
...	...	...	'05	...	...	'01	...	...	...	...	...	'01	...	0'79	
'04	'01	'01	'02	'01	...	'01	'01	...	...	'20	'21	'06	...	1'01	
'01	...	...	...	'02	'33	...	'32	'54	...	...	...	'16	...	1'73	
...	'18	'02	'15	...	...	...	...	'02	...	...	...	...	...	0'46	
...	...	...	'19	...	...	'01	...	...	...	...	...	...	...	0'49	
'05	'05	...	'01	'01	...	...	'05	'01	'10	...	...	...	'08	0'76	
'16	'24	'03	'06	'01	'08	'01	'03	'46	...	'14	...	...	...	1'75	
'61	...	...	...	...	...	'02	'02	...	'27	'10	'35	'01	...	4'03	
'12	'22	...	'01	...	...	...	...	...	...	'04	...	...	...	1'22	
...	...	'01	'04	'08	'01	'02	...	...	...	...	...	...	'70	1'28	
...	'03	'14	...	...	...	'57	...	'13	...	...	...	'05	...	2'34	

TABLE III. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1815.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1816.	...	'02	'06	...	...	...	...	'25	'18	'14	'02	'07	'20	'20	'08
1817.	...	'06	...	'08	'12	'12	'16	'35	'16	...	'01	'26	'12	...	...
1818.	...	'01	'14	'72	'10	'16	...	'55	'02	...	...	...	...	...	...
1819.	'02	'20	'31	'18	'68	'08	'14	...	'40	'01	'03	'24	'07	'05	...
1820.	'22	'44	'01	...	...	'02	...	...	...	...	...	...	...	...	...
1821.	...	'15	...	...	...	...	'13	...	...	...	...	...	...	...	...
1822.	'26	...	'30	'24	'12	...	'47	'30	'18	'10	...	...	...	'10	...
1823.	...	...	...	...	'11	'08	...	...	'48	...	...	...	...	...	'07
1824.	...	...	...	...	...	...	...	...	'16	'08	...	...	...	...	...
1825.	...	...	'07	...	...	...	...	...	'46	'05	'22	...	...	...	...
1826.	...	'40	'55	...	'03	...	...	...	...	...	'20	...	...	'12	...
1827.	...	...	'42	'15	...	'12	'10	'12	...	...	...	...	...	'11	'12
1828.	'21	...	...	...	...	...	1'00	...	'10	...	...	...	'22	'17	...
1829.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1830.	...	...	...	...	...	...	...	'11	'23	...	...	...	...	...	...
1831.	...	'03	'40	'21	...	'10	'04	'01	'08	'18	'03	'06	'29	'43	'28
1832.	'01	'01	'19	'45	...	'12	'39	...	...	...	...	...	...	'12	'21
1833.	...	'03	...	'01	'04	...	...	...	'01	...	...	...	...	...	...
1834.	...	...	...	'01	'12	'01	...	...	...	...	...	...	...	...	...
1835.	'10	'02	'03	'11	'10	'39	'06	'03	'25	'11	'39	'46	'25	'51	'05
1836.	'35	'05	'08	'08	'25	'03	...	...	'33	'10	'08	'05	'33	'68	...
1837.	'12	'10	...	...	...	...	...	...	...	'12	...	...	'08	...	...
1838.	...	...	...	'25	'16	...	...	...	...	...	...	...	'03	...	...
1839.	...	...	...	...	...	...	'06	...	...	...	...	...	'30	'25	'18
1840.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1841.	'02	'23	...	'06	'13	...	...	...	...	...	...	...	...	...	...
1842.	...	'25	...	...	...	...	'01	'07	'45	...	...	...	'04	...	...
1843.	...	...	...	...	...	...	...	...	...	...	...	...	'07	...	'02
1844.	'03	'09	'20	'48	...	...	...	...	'57	'07	...	'15	...	'36	...
1845.	...	'15	'31	...	...	...	...	...	...	'02	...	...	...	...	...
1846.	...	...	'01	'14	'10	'05	'05	...	...	...	...	...	'05	...	...
1847.	...	...	...	...	'01	...	...	...	...	...	'03	...	...	...	...
1848.	'18	'01	'04	...	'40	'01	...	'03	...	'01	'37	'01	'11	...	'08
1849.	'10	...	...	...	...	...	'05	'05	'02	...	...	...	...	...	...
1850.	...	...	...	'04	...	...	...	...	...	...	...	...	...	...	...
1851.	...	...	...	...	'10	...	...	...	...	'05	...	'10	'01	...	1'45
1852.	'02	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1853.	'31	'17	...	...	'20	...	'11	'02	'04	...	...	...	...	'50	...
1854.	...	...	...	...	...	...	...	...	...	'03	...	...	...	...	...
1855.	'12	'23	'12	...	...	...	...	...	...	...	'10	'33	'05	...	...
1856.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1857.	...	...	...	...	...	...	...	'15	...	...	...	...	...	'03	'15
1858.	...	'04	'30	...	...	'01	'06	'25	'08	...	...	'02	...	...	...
1859.	...	...	...	...	...	...	'01	'02	'07	...	'04	'01	'05	'05	'05
1860.	...	'04	'05	'46	'01	'01	'18	'05	'05	'04	...	'07	'13	...	...
1861.	'28	'08	'05	'07	'01	'05	...	...	...	'04	'19	'10	'04	'01	'02
1862.	...	...	...	...	'13	'03	'05	'05	'21	'02	'15	'01	'07	'05	...
1863.	...	'02	...	...	...	'07	'15	'12	...	'02	...	'05	...	'02	'21
1864.	'03	...	'21	'32	'01	'42	'09	'19	'62	'11	'11	...	...	...	'06
1865.	'02	'16	...	...	'16	'17	...	...	...	...	'10	...	...	...	...
1866.	'01	...	...	...	...	'07	...	'02	...	'01	...	...	...	...	...
1867.	...	...	...	...	...	'04	'11	'04	'34	'18	'05	'17	'04	'49	'01
1868.	'01	...	'07	...	'01	'01	'03	'17	...	...	'14	'02	'01	'02	...
1869.	'18	'24	...	...	...	...	...	'01	...	...	'02	...	'01	'05	...

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

93

Day in MARCH during the Years from 1815 to 1869.

the Month.																Sums.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	ins.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'07	'01	...	'15	...	...	'02	'12	'04	'08	...	'12	'16	'01	...	...	2.00
'08	...	'17	...	'02	...	...	...	...	...	...	...	...	...	...	...	1.71
...	...	...	...	...	...	...	...	...	'05	'02	'12	...	'01	...	...	1.90
'05	'01	...	...	...	...	...	'35	'10	...	'48	...	...	...	'05	...	3.45
'03	...	...	'08	...	'08	...	...	'10	'17	'03	...	'29	...	'09	'02	1.58
...	...	...	...	'01	'09	'03	...	...	...	'10	'08	...	...	...	...	0.59
...	...	'11	'11	...	...	'01	...	...	'20	'05	'11	'33	'35	...	'11	3.45
...	...	...	...	...	...	'02	...	...	'15	'25	...	'02	'13	'08	'13	1.39
...	...	'15	'22	...	...	...	...	...	...	...	...	...	...	...	75	1.36
'16	...	...	...	...	...	'32	'30	...	...	...	...	'11	...	...	...	1.69
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1.30
...	...	...	...	'11	...	...	...	...	'41	...	...	...	...	...	...	1.66
...	'30	...	...	...	...	'10	...	...	...	...	...	...	'30	...	...	2.40
...	'04	...	'02	...	'06	'04	...	...	...	'08	'10	'52	...	...	...	0.86
...	...	'03	...	'02	...	...	...	...	...	...	...	...	'50	...	'05	0.60
'10	...	...	'01	...	...	'01	...	...	...	...	...	...	...	...	'26	0.72
...	...	...	...	...	...	...	...	'04	'49	'20	...	...	...	...	...	2.93
'17	...	'02	'06	...	...	...	'11	'13	...	...	...	...	...	...	...	3.02
...	'13	'13	...	...	'06	'53	...	'08	'13	...	...	...	'06	...	'11	1.32
...	...	...	...	...	...	'01	...	...	...	...	'04	'13	...	'30	...	0.62
'03	'13	...	...	...	'08	...	...	...	...	...	...	...	...	...	'06	3.16
'10	'03	...	...	...	...	'08	'25	'05	'03	'43	...	'10	'30	...	...	3.78
...	...	...	...	...	'05	...	...	...	...	...	...	...	'20	...	...	0.45
...	'15	...	...	...	'05	...	'03	'02	...	...	...	...	...	...	...	0.91
'10	...	...	...	'05	'05	...	...	'08	'04	'06	'20	'22	...	...	...	1.59
'10	...	...	...	...	...	...	...	...	...	...	'10	...	...	...	'05	0.25
...	'02	...	...	'10	'03	'05	...	...	...	'03	...	'01	'05	'04	'03	0.61
...	'03	...	'07	'08	'07	'05	...	...	'04	...	...	...	...	'10	'50	1.76
...	...	...	...	'13	...	...	...	...	...	...	...	...	...	...	'08	0.30
...	...	...	...	...	...	'07	...	...	...	...	...	...	...	...	...	2.02
...	...	...	...	...	'03	...	'55	...	...	...	...	...	...	...	...	1.06
'11	...	...	'10	...	'06	'05	'01	...	'09	'02	...	'04	...	...	...	0.88
...	...	...	...	...	...	...	...	...	...	...	...	'25	'05	...	...	0.34
'20	'40	'01	'10	'20	'29	...	'04	...	...	'04	'06	'25	'16	...	...	3.00
...	...	...	...	...	...	...	...	...	...	...	'16	'06	'01	'02	'04	0.47
...	...	...	'02	...	...	'01	'09	...	...	...	...	'17	...	...	'03	0.36
'06	'34	'15	'30	'07	'01	'20	'30	'03	'02	'27	'02	...	'20	'03	'02	3.73
...	...	...	...	...	...	...	...	...	...	...	...	...	...	'11	'01	0.14
...	'01	...	...	...	'02	...	'01	'04	'03	...	'02	...	'01	...	...	1.49
...	...	'13	'14	...	'02	'01	...	...	...	'03	...	...	...	...	...	0.36
'15	'07	'04	'01	...	...	'23	...	...	...	...	...	'01	...	...	...	1.46
'08	'85	'30	'01	'02	'03	...	...	...	...	...	...	...	...	...	...	1.29
...	...	...	'06	...	...	'05	...	...	'02	...	...	...	'05	'15	'04	0.97
...	...	...	...	...	...	...	...	...	...	...	...	...	...	'02	'10	0.88
...	'06	...	...	...	'64	...	...	...	...	...	...	'01	'05	'41	...	1.47
...	'10	'01	...	...	'06	'01	'19	'01	'04	...	...	'01	'06	'01	'12	1.71
'18	'36	...	'07	'22	'01	...	...	...	'21	...	...	'07	...	'06	'17	2.29
'01	'72	'13	...	'41	'60	...	'52	...	'09	'07	'05	'11	...	...	'07	3.55
'01	...	...	...	...	...	...	...	...	...	...	...	...	...	'01	...	0.69
...	...	...	...	...	...	...	...	...	...	'04	...	'10	'03	'19	...	2.53
...	...	...	...	...	...	...	...	...	'17	'01	...	'03	...	...	...	0.85
...	'17	'01	'03	'21	'03	...	'12	'49	'01	...	'14	...	'01	...	'30	1.63
'01	...	'08	'22	...	...	'18	'03	'04	'13	...	'02	'01	...	'09	...	2.28
...	'05	...	'01	'01	...	...	'08	...	...	'41	...	...	...	...	...	1.07
...	'01	'04	'09	'38	'20	...	...	...	'02	'03	'03	'03	'06	...	'02	1.41

TABLE IV. Showing the fall of Rain on every

[illegible]

TABLE V. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1815.	in. '09	...	in. '62	...	...	in. '15	in. '02	in. '08	...	in. '01	in. '04	in. '42	in. '21	in. '10	in. '02
1816.	...	in. '01	in. '01	in. '27	in. '20	in. '01	...	in. '10	in. '31	in. '25	in. '29	...	in. '02	...	in. '10
1817.	in. '10	...	...	...	...	...	...	...	in. '48	...	...	...	in. '10	...	in. '07
1818.	in. '25	...	in. '41	in. '08	...	in. '01	in. '03	in. '13	in. '34	...	...	in. '03	in. '10	in. '01	...
1819.	...	...	in. '02	in. '17	in. '10	...	in. '03	...	...	in. '08	...	...	...	...	...
1820.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1821.	...	...	...	...	...	...	in. '09	in. '05	in. '08	...	...	...	in. '02	in. '03	in. '52
1822.	...	...	...	...	in. '26	in. '03	in. '07	in. '52	...	...	in. '16	in. '04	...	in. '01	...
1823.	...	...	...	...	...	...	...	...	in. '04	...	...	in. '28	...	...	...
1824.	...	...	in. '39	in. '20	...	in. '16	...	...	in. '05	...	...	...	in. '25	in. '34	in. '79
1825.	...	in. '79	...	...	in. '10	...	...	...	...	in. '04	...	...	in. '40	...	...
1826.	...	...	...	in. '05	...	...	...	in. '06	...	...	...	...	...	...	...
1827.	...	...	...	...	...	in. '41	in. '27	...	...	...	...	...	...	...	in. '13
1828.	...	...	in. '16	...	...	...	...	in. '19	...	...	...	...	...	...	...
1829.	...	...	...	in. '03	...	...	...	in. '12	...	...	...	...	...	...	...
1830.	...	...	...	...	...	...	...	in. '83	in. '26	...	...	...	...	...	...
1831.	...	in. '97	in. '24	in. '15	in. '06	...	...	...	...	...	...	...	...	...	...
1832.	...	in. '58	in. '29	in. '29	...	in. '15	...	...	...	...	in. '11	in. '01	in. '06	in. '01	...
1833.	in. '15	in. '01	...	...	...	...	...	...	...	...	...	...	...	...	...
1834.	...	...	...	...	...	...	...	...	...	...	in. '09	in. '25	in. '07	in. '16	...
1835.	in. '23	in. '03	in. '07	in. '01	in. '13	...	...	...	...	in. '01	...	in. '06	in. '00	in. '06	in. '35
1836.	...	...	...	in. '74	...	...	...	...	...	...	...	...	...	...	...
1837.	...	...	...	...	...	...	...	in. '33	...	...	...	in. '20	in. '10	in. '09	in. '02
1838.	in. '15	in. '05	...	...	in. '03	...	...	...	...	...	...	...	in. '07	...	...
1839.	...	in. '06	...	...	...	...	...	in. '28	in. '56	...	in. '02	in. '08	in. '25	in. '05	...
1840.	...	...	...	...	...	...	in. '05	in. '10	in. '30	in. '05	in. '02	in. '23	...	...	in. '25
1841.	...	in. '25	in. '25	in. '61	in. '02	...	in. '16	in. '07	...	...	in. '01	...	...	...	...
1842.	...	...	in. '17	...	in. '11	in. '35	in. '08	in. '25	in. '02	...	in. '48	in. '01	...	...	...
1843.	...	...	in. '01	in. '11	in. '74	in. '27	in. '25	in. '44	...	...	...	...	...	in. '20	in. '06
1844.	...	...	...	...	...	...	in. '01	...	in. '02	...	...	...	...	...	...
1845.	...	...	...	...	in. '12	in. '14	in. '16	...	...	...	in. '06	in. '13	...	...	...
1846.	...	...	...	...	...	in. '05	...	...	...	in. '01	...	...	in. '37	...	...
1847.	...	in. '08	in. '16	in. '01	...	...	in. '06	in. '05	in. '08	in. '05	...	...	in. '04	...	in. '24
1848.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1849.	...	in. '03	in. '14	...	...	...	...	...	in. '02	in. '04	...	...	...	in. '07	...
1850.	in. '02	...	...	in. '09	in. '04	in. '65	in. '20	in. '24	in. '06	...	...	in. '01	in. '02	in. '11	in. '02
1851.	...	...	in. '10	...	in. '14	...	...	...	...	...	...	in. '05	in. '01	in. '01	...
1852.	in. '02	...	...	...	...	...	...	...	...	in. '01	in. '10	in. '14	in. '05	...	...
1853.	...	...	in. '50	in. '04	...	...	...	in. '30	in. '02	in. '20	in. '03	...	in. '02	in. '10	...
1854.	in. '21	in. '09	in. '04	...	in. '01	in. '01	in. '03	in. '76	in. '52	...	...	...	...	...	...
1855.	...	...	...	...	...	...	...	in. '07	in. '07	in. '09	in. '29	...	in. '35	in. '05	...
1856.	in. '01	...	in. '07	...	...	...	in. '32	in. '01	...	...	...	in. '15	in. '63	in. '01	in. '11
1857.	...	...	...	...	...	...	...	...	...	...	in. '05	in. '03	...	...	...
1858.	in. '09	in. '15	in. '01	in. '05	...	...	...	...	...	...	in. '04	in. '03	in. '24	in. '19	in. '07
1859.	...	...	...	...	...	...	...	in. '34	...	...	...	...	...	...	...
1860.	...	...	...	...	...	...	...	in. '03	in. '01	in. '11	in. '08	in. '42	in. '74	in. '95	in. '02
1861.	...	...	in. '05	in. '07	...	...	in. '04	in. '02	...	in. '76	in. '07	in. '02	...	...	...
1862.	in. '11	...	...	in. '02	in. '01	in. '03	in. '58	in. '03	in. '77	in. '02	in. '09	...	...	...	in. '69
1863.	...	...	...	...	...	...	...	...	...	...	in. '01	in. '32	in. '03	in. '04	in. '08
1864.	...	in. '11	in. '18	in. '19	...	...	in. '38	in. '07	in. '28	...	in. '04	...	...	...	...
1865.	...	in. '02	in. '05	in. '09	...	...	in. '56	...	in. '57	in. '98	in. '58	in. '01	...	in. '06	in. '02
1866.	in. '10	...	in. '13	...	in. '08	...	...	...	in. '03	...	in. '42	in. '05	...	...	...
1867.	in. '03	...	...	...	...	...	...	...	...	in. '06	in. '31	in. '11	in. '01	...	...
1868.	...	...	...	...	...	...	...	...	in. '03	...	...	...	...	...	...
1869.	...	...	in. '37	in. '63	...	in. '08	in. '03	in. '17	in. '03	in. '11	in. '21	...	...	...	...

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

97

Day in MAY during the Years from 1815 to 1869.

the Month.																Sum.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'10	...	...	'02	...	'03	'01	...	'10	...	...	...	...	...	'12	...	2'14
...	'01	...	...	...	...	...	...	...	'01	'16	'20	...	...	...	...	1'95
'10	'01	'05	'30	'74	'84	'48	'05	...	'28	'10	...	'04	'21	'07	...	4'13
...	'10	'04	...	...	...	...	...	...	...	...	...	...	...	...	...	2'53
...	...	...	'43	'14	'50	'06	...	'35	'10	...	...	...	...	...	...	2'98
1'10	'20	'38	'13	'21	...	...	...	...	'50	'10	'40	'05	'10	'40	...	3'57
'20	'10	'60	...	'10	...	...	...	'02	...	'20	...	'10	'11	...	...	2'22
...	'06	...	...	...	...	...	...	...	'01	'57	'15	'02	...	...	...	1'90
...	...	'10	...	...	'12	...	'10	'07	...	'03	...	...	...	...	...	0'74
1'25	...	...	'06	'05	...	'01	'02	'12	'07	...	...	...	...	...	'01	3'77
...	...	...	...	...	...	...	...	...	...	...	'31	'33	...	...	...	2'97
...	...	...	'11	'04	...	...	...	...	'58	'13	'03	...	'50	'92	'05	2'47
...	'16	'44	...	...	...	'11	...	'12	'15	'48	...	'07	...	'05	...	2'39
...	...	...	...	...	...	...	'04	'55	...	...	'20	'17	'12	'04	...	1'47
...	...	'02	...	...	...	...	...	...	'28	...	...	...	...	...	...	0'45
...	...	...	...	...	'23	'02	'83	...	'58	'23	'01	'08	'48	'21	...	3'76
...	...	...	'07	'46	...	...	...	'28	...	...	...	...	'36	...	...	2'59
...	'23	...	...	...	...	...	...	...	...	...	...	'01	'12	'49	'39	2'74
...	...	...	'22	...	...	...	...	...	...	...	...	...	...	...	...	0'38
...	'01	'01	'03	...	...	...	...	...	...	...	...	...	...	...	...	0'62
...	...	...	...	'01	...	'03	...	...	...	...	'34	'13	...	...	'17	2'62
...	...	...	...	...	'10	...	'01	...	...	...	...	...	...	...	...	0'76
...	...	...	...	...	'03	...	'03	'02	'05	...	...	...	'15	'08	...	0'89
'10	...	...	...	...	'05	...	...	'06	...	...	...	...	...	...	...	1'51
'40	'12	'03	...	'06	...	...	...	'20	...	'06	...	...	...	...	...	1'87
...	'03	'01	...	'06	...	...	...	...	...	...	'09	'04	...	...	...	1'60
...	...	'01	'02	...	...	'05	'20	'09	...	'17	...	'12	'08	'01	'04	2'01
'07	'20	'08	...	'22	...	'05	'35	...	...	...	'25	'12	'08	'01	'04	3'55
...	...	...	...	...	...	...	...	...	...	...	...	...	'12	...	...	0'15
...	'08	...	'07	'35	'02	'08	'07	'25	'08	...	'04	'33	...	...	...	1'98
'37	'06	'05	'36	'20	...	...	...	...	...	...	...	...	...	...	...	1'47
...	...	'09	...	...	...	...	...	...	...	...	...	'19	...	...	...	1'05
...	...	...	...	'03	'02	...	...	...	...	...	...	...	...	...	'17	0'22
'47	'04	'04	'05	'90	'12	'34	...	'01	...	...	...	1'15	'45	...	...	3'87
...	'05	'01	'07	'01	...	'18	...	...	'21	'07	'03	'26	...	...	...	2'35
...	...	'20	'03	...	...	...	...	...	'18	'01	'03	...	...	...	...	0'76
...	'38	'26	'10	'10	...	...	...	...	...	'56	...	'01	'30	...	...	2'03
...	...	...	...	...	...	...	...	...	...	...	'03	'10	'25	'02	...	1'61
'03	'01	...	...	'03	'14	'28	...	...	'05	'37	'19	'50	'04	...	...	3'27
'05	'29	'26	'02	...	...	'65	'01	'14	'13	...	...	'59	...	...	'25	1'76
...	...	...	...	...	...	'28	'07	...	'12	...	...	...	...	...	...	0'55
'09	'06	'04	'03	...	...	'07	'33	'34	'16	...	...	...	...	...	...	1'99
'34	...	'07	'44	'84	...	...	...	...	...	...	...	'13	'26	'05	'11	2'58
'01	'21	'20	...	...	...	...	...	...	'04	'20	'01	'11	...	...	'56	3'70
'01	'01	...	...	'01	...	'46	'01	...	...	...	...	'02	...	...	...	1'55
'14	...	...	...	'17	'02	...	...	...	...	...	'06	...	'03	'07	...	2'84
'02	...	...	'33	'33	'07	...	...	...	...	...	...	...	...	...	'02	1'25
...	...	...	...	...	'22	...	...	...	...	...	...	...	'03	...	'50	2'00
...	...	...	...	...	'33	1'03	...	...	...	...	...	'07	...	...	...	4'37
...	...	...	...	...	'73	'30	'10	...	...	'29	'31	...	'02	'07	...	2'34
...	...	...	...	...	...	'20	'06	'29	'01	...	...	...	1'08	...	...	1'67
'05	'01	'24	'33	'01	'03	'01	...	'02	'01	'12	'11	'85	'01	...	...	3'43

TABLE II. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	'06	'05	'01	'09	...	...	'01	...	'10	'01	'02	'12	'23	...	'07
1816.	...	...	'17	'04	'02	'29	...	'58	...	...	...	...	...	...	...
1817.	...	...	...	...	'01	'02	...	...	'01	...	'20	'14	'05	'14	'17
1818.	...	'26	...	...	...	...	...	...	...	...	...	'06	...	...	...
1819.	'14	'16	...	'06	'10	'10	'26	...	'11	'20	...	...	'15	'09	...
1820.	...	...	...	...	...	'03	...	...	...	...	'10	'20	'40	'21	'40
1821.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1822.	...	...	'30	...	'08	...	...	'29	'03	'01	...	'11	...	...	...
1823.	'23	...	'33	'20	...	...	...	'44	...	'19	'25	'08	'15	...	...
1824.	...	...	...	'09	'11	...	...	...	'11	...	...	...	...	'18	...
1825.	...	'08	...	...	...	...	...	'40	...	...	...	...	...	...	...
1826.	...	'05	...	'07	...	'14	...	...	...	...	...	...	...	'10	...
1827.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1828.	'14	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1829.	...	...	...	'20	'14	...	...	...	...	...	...	...	...	'15	...
1830.	'03	...	...	...	...	...	'32	'66	'04	...	...	...	...	...	...
1831.	...	...	...	...	...	...	2'89	'03	...	...	'03	'06	'05	...	'02
1832.	'10	...	...	...	'25	...	...	'13	...	...	...	...	...	...	...
1833.	'55	'05	'04	...	...	'10	'01	'61	'46	'21	'22	'29	'37	'82	...
1834.	...	...	...	'01	'25	...	...	...	'13	'12	'03	...	...	...	...
1835.	'06	...	...	...	'03	...	'02	'08	...	'04	'04	'25	...	...	...
1836.	...	'88	'29	'08	...	...	'21	...	'03	...	...	...	'17	...	...
1837.	...	...	...	...	...	...	...	...	...	'30	'20	...	'05	...	...
1838.	...	...	...	...	...	...	'10	...	'12	...	...	...	...	...	...
1839.	...	...	'22	'08	'35	'02	...	...	'06	...	'06	...	...	...	...
1840.	'15	...	...	'13	'30	'10	...	...	'15	...	...	...	'06	...	'15
1841.	...	...	...	...	...	...	...	...	...	'10	'02	...	...	...	'07
1842.	...	...	...	...	...	'02	'02	'04	...	'06	...	...	'03	...	...
1843.	...	'03	'30	'01	...	...	'50	'02	'06	...	...	...	...	...	...
1844.	...	'19	...	...	...	'17	'11	'33	...	...	...	...	...	...	'01
1845.	...	'07	...	...	...	...	...	...	...	...	...	...	'25	...	...
1846.	'70	...	...	'35	...	...	'06	...	...	...	...	...	...	...	...
1847.	...	...	'07	...	'03	...	...	'37	...	...	...	...	'22	'15	'26
1848.	...	...	...	...	'10	'04	'30	...	'40	'12	...	...	...	'03	'04
1849.	'01	'02	'02	...	...	...	...	'06	...	...	...	...	...	...	...
1850.	'24	'01	...	...	'20	...	...	'03	'09	...	'10	'06	...	'15	'05
1851.	...	'16	'05	'01	'07	'08	'02	...	...	...	...	...	'05	'01	...
1852.	...	'03	...	'14	'14	'01	...	'12	'07	'03	...	...	...	...	...
1853.	...	'01	...	'06	...	...	...	...	...	'05	'01	...	'20	'05	...
1854.	'38	...	'04	'05	'13	...	...	'12	...	...	...	...	...	...	'13
1855.	'16	...	'05	'15	'05	...	'05	'48	...	...	...	...	...	...	...
1856.	...	...	...	'02	'03	...	...	'14	...	...	'23	'05	'17	'10	...
1857.	...	...	'08	...	...	...	...	...	'08	'01	...	...	...	...	...
1858.	...	'30	...	'47	...	...	...	...	...	...	...	'01	'07	'81	'06
1859.	...	'09	...	'12	'03	'20	'03	'01	'14	'04	'02	...	...	'04	...
1860.	...	...	'01	...	...	'31	'01	...	'06	...	'01	...	'02	...	'01
1861.	...	...	...	...	...	...	'01	'01	'11	...	'03	...	'04	'05	'10
1862.	'05	...	...	...	...	...	...	...	...	...	...	...	'04	...	...
1863.	'01	'07	'09	'01	'02	...	...	'08	...	...	...	'01	...	...	...
1864.	...	...	'03	...	'03	...	...	'01	...	...	...	'33	...	...	...
1865.	'03	'02	...	'01	'01	'12	'08	'09	...	...	'08	...	'09	...	...
1866.	'07	'33	'17	'34	...	...	'09	...	'26	'21	'72	'10	...	'34	'02
1867.	'09	...	...	'08	'07	'08	'18	'01	'06	...	'24	...	...	...	'02
1868.	'02	'25	...	...	...	...	'02	'09	...	...	...	...	...	...	'04
1869.	'32	'01	'07	'04	...	...	...	'02	'09	...	'10	'77	...	...	...

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

91

Day in FEBRUARY during the Years from 1815 to 1869.

the Month.														Suma
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'03	'12	'08	...	'02	'16	...	...	...	...	...	'02	...	...	1'20
'04	...	...	'08	...	...	...	...	...	...	'15	'10	...	...	1'47
'05	'05	'03	'02	...	'05	'05	'01	...	'05	'08	'07	'04	...	1'19
'08	...	'02	'11	'15	...	'22	'40	'11	'10	'08	'22	...	...	1'81
'02	...	'16	'13	...	'20	'11	'46	'02	...	'10	'08	'02	...	2'67
...	...	...	...	...	...	...	'08	'06	'35	'11	...	...	...	1'94
...	...	...	...	...	'04	...	...	...	...	...	...	...	...	0'04
'03	...	...	...	'01	'10	...	...	...	...	...	'02	...	...	0'98
...	'16	...	'25	'01	...	'25	...	'48	...	'12	'03	...	...	3'17
...	...	...	...	'25	'15	...	...	'15	...	...	...	'21	'09	2'34
...	...	'19	...	...	...	...	...	...	...	...	'11	'08	...	0'86
...	'35	'12	...	'10	'12	'17	'15	...	'26	...	...	'03	...	1'66
...	...	...	...	...	...	...	...	...	...	...	...	'60	...	0'60
...	...	...	...	'70	...	'05	...	...	'04	...	...	...	'11	1'04
...	...	...	...	...	'13	...	...	...	...	...	'55	...	...	1'17
...	...	'01	...	...	'66	'38	'05	...	'14	'08	...	...	...	2'37
'07	...	...	'10	...	'04	'01	'03	'06	'14	'19	'19	...	...	3'91
...	...	...	...	...	...	...	...	'23	...	'20	'13	'03	...	1'07
...	'24	...	'41	'46	...	...	'02	'15	'28	'17	'14	'10	...	5'70
...	...	...	'10	...	'01	'01	'06	...	...	...	'03	'06	...	0'81
...	'03	'18	'63	'40	...	'58	...	...	'43	'22	'01	'40	...	3'40
...	...	...	...	...	...	...	...	...	...	'70	...	'05	'10	2'51
...	...	'18	'57	...	'07	...	...	...	...	...	...	'15	...	1'52
...	'29	...	...	...	'03	...	'45	'22	...	'50	'10	...	...	1'81
'15	'06	...	...	...	...	'16	'18	...	'02	...	'03	'02	...	1'41
'05	...	...	...	...	...	...	...	...	...	...	...	...	...	1'09
'14	...	'09	...	'10	'01	...	...	...	'07	'14	'03	...	...	0'77
...	...	...	...	'14	...	'06	'06	...	'04	'18	'04	...	...	0'69
...	...	...	'35	'08	'10	'02	...	...	'58	'03	'12	...	...	2'20
'01	...	'03	'05	...	...	'39	...	'25	'05	'05	'05	'11	...	1'88
...	...	...	...	...	...	'25	...	'20	...	...	...	...	...	0'77
...	...	...	...	...	'19	'05	'08	...	...	...	'02	...	...	1'45
'15	...	'01	...	...	...	...	...	...	...	...	...	...	...	1'26
...	...	...	'12	'10	'07	'11	...	'02	'14	'30	'35	'03	'20	2'47
...	...	...	'40	'02	...	...	...	'25	'20	'40	...	'78	...	2'16
'17	...	...	...	'19	...	...	...	...	...	...	...	...	...	1'29
...	...	...	'20	'10	...	...	...	'03	...	...	'08	...	...	0'86
'03	...	...	...	...	...	...	...	...	...	'01	...	'15	...	0'73
'05	...	'03	...	...	...	'10	'02	'05	'10	'12	...	...	...	0'85
...	'08	...	...	...	...	...	'10	...	...	...	...	...	...	1'03
...	...	...	...	...	...	'10	...	'16	'05	'12	'01	...	...	1'38
...	...	'01	'10	'08	...	...	...	...	...	...	...	...	...	0'93
...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'17
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1'72
...	...	'05	...	...	'01	...	...	...	...	...	'01	...	...	0'79
'04	'01	'01	'02	'01	...	'01	'01	...	...	'20	'21	'06	...	1'01
'01	...	...	'02	'33	...	'32	'54	...	...	...	...	'16	...	1'73
...	'18	'02	'15	...	...	...	...	'02	...	...	...	...	...	0'46
...	...	...	'19	...	...	'01	...	...	...	...	...	...	...	0'49
'05	'05	...	'01	...	...	'05	'01	'10	...	...	...	...	'08	0'76
'16	'24	'03	'06	'01	'08	'01	'03	'46	...	'14	...	...	...	1'75
'61	...	...	...	...	...	'02	'02	...	'27	'10	'35	'01	...	4'03
'12	'22	...	'01	...	...	...	...	...	...	'04	...	...	...	1'22
...	...	'01	'04	'08	'01	'02	...	...	...	...	...	...	'70	1'28
...	'03	'14	...	...	...	'57	...	'13	...	...	...	'05	...	2'34

TABLE III. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	...	'02	'06	...	...	...	...	'25	'18	'14	'02	'07	'20	'20	'08
1816.	...	'06	...	'08	'12	'12	'16	'35	'16	...	'01	'26	'12	...	...
1817.	...	'01	'14	'72	'10	'16	...	'55	'02	...	...	...	...	...	...
1818.	'02	'20	'31	'18	'68	'08	'14	...	'40	'01	'03	'24	'07	'05	...
1819.	'22	'44	'01	...	...	'02	...	...	...	...	...	...	...	...	...
1820.	...	'15	...	...	...	...	'13	...	...	...	...	...	...	...	...
1821.	'26	...	'30	'24	'12	...	'47	'30	'18	'10	...	...	...	'10	...
1822.	...	...	...	...	'11	'08	...	...	'48	...	...	...	...	...	'07
1823.	...	...	...	...	...	...	...	...	...	'16	'08	...	...	...	...
1824.	...	...	'07	...	...	...	...	...	'46	...	'05	'22	...	...	...
1825.	...	'40	'55	...	'03	...	...	...	...	...	...	'20	...	'12	...
1826.	...	...	'42	'15	...	'12	'10	'12	...	...	...	...	...	'11	'12
1827.	'21	...	...	...	...	...	1'00	...	'10	...	...	...	'22	'17	...
1828.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1829.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1830.	...	...	...	...	...	...	...	'11	'23	...	...	...	...	...	...
1831.	'03	'40	'21	...	'10	'04	'01	'08	'18	'03	'06	'29	'43	'28	'06
1832.	'01	'01	'19	'45	...	'12	'39	...	...	...	...	...	'12	'21	'03
1833.	...	'03	...	'01	'04	...	...	...	'01	...	...	...	...	...	...
1834.	...	...	...	'01	'12	'01	...	...	...	...	...	...	...	...	...
1835.	'10	'02	'03	'11	'10	'39	'06	'03	'25	'11	'39	'46	'25	'51	'05
1836.	'35	'05	'08	'08	'25	'03	...	...	'33	'10	'08	'05	'33	'68	...
1837.	...	...	...	...	...	...	...	...	...	'12	...	...	'08	...	...
1838.	'12	'10	...	'25	'16	...	...	...	...	...	...	...	'03	...	...
1839.	...	...	...	...	...	...	'06	...	...	...	...	...	'30	'25	'18
1840.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1841.	'02	'23	...	'06	'13	...	...	...	...	...	...	...	...	...	...
1842.	...	'25	...	...	...	...	'01	'07	'45	...	...	...	'04	...	...
1843.	...	...	...	...	...	...	...	...	...	...	...	...	'07	...	'02
1844.	'03	'09	'20	'48	...	...	...	...	'57	'07	...	'15	...	'36	...
1845.	...	'15	'31	...	...	...	...	...	...	'02	...	...	...	...	...
1846.	...	...	'01	'14	'10	'05	'05	...	...	...	...	...	'05	...	...
1847.	...	...	...	...	...	'01	...	...	...	...	'03	...	...	...	...
1848.	'18	'01	'04	...	'40	'01	...	'03	...	'01	'37	'01	'11	...	'08
1849.	'10	...	...	...	...	...	'05	'05	'02	...	...	...	...	...	...
1850.	...	...	...	'04	...	...	...	...	...	...	...	...	...	...	...
1851.	...	...	...	...	'10	...	...	...	...	'05	...	'10	'01	...	1'45
1852.	'02	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1853.	'31	'17	...	...	'20	...	'11	'02	'04	...	...	...	...	'50	...
1854.	...	...	...	...	...	...	...	...	...	'03	...	...	...	...	...
1855.	'12	'23	'12	...	...	...	...	...	...	...	'10	'33	'05	...	...
1856.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1857.	...	...	...	...	...	...	...	'15	...	...	...	...	'03	'15	'27
1858.	...	'04	'30	...	...	'01	'06	'25	'08	...	...	'02	...	...	...
1859.	...	...	...	...	...	...	'01	'02	'07	...	'04	'01	'05	'05	'05
1860.	...	'04	'05	'46	'01	'01	'18	'05	'05	'04	...	'07	'13	...	...
1861.	'28	'08	'05	'07	'01	'05	...	...	...	'04	'19	'10	'04	'01	'02
1862.	...	...	...	...	'13	'03	'05	'05	'21	'02	'15	'01	'07	'05	...
1863.	...	'02	...	...	...	'07	'15	'12	...	'02	...	'05	...	'02	'22
1864.	'03	...	'21	'32	'01	'42	'09	'19	'62	'11	'11	...	...	...	'06
1865.	'02	'16	...	...	'16	'17	...	'02	...	...	'10	...	...	...	...
1866.	'01	...	...	...	...	'07	...	'02	...	'01	...	...	...	...	...
1867.	...	...	...	...	...	'04	'11	'04	'34	'18	'05	'17	'04	'49	'01
1868.	'01	...	'07	...	'01	'01	'03	'17	...	...	'14	'02	'01	'02	...
1869.	'18	'24	...	...	...	...	...	'01	...	...	'02	...	'01	'05	...

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

93

Day in MARCH during the Years from 1815 to 1869.

the Month.																Sum.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'07	'01	...	'15	...	...	'02	'12	'04	'08	...	'12	'16	'01	...	...	2 00
'08	...	'17	...	'02	...	...	...	...	...	...	...	...	...	...	...	1 71
...	...	...	...	...	...	...	...	...	'05	'02	'12	...	'01	...	...	1 90
'05	'01	...	...	...	...	...	'35	'10	...	'48	...	...	...	'05	...	3 45
'03	...	...	'08	...	'08	...	...	'10	'17	'03	...	'29	...	'09	'02	1 58
...	...	...	...	...	'01	'09	'03	...	...	'10	'08	...	...	...	...	0 59
...	...	'11	'11	...	...	'01	...	...	'20	'05	'11	'33	'35	...	'11	3 45
...	...	...	...	...	...	'02	...	...	'15	'25	...	...	'02	'13	'08	1 39
'16	...	'15	'22	...	...	...	'32	'30	...	...	...	'11	...	...	'75	1 36
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 69
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 30
...	...	...	...	'11	...	...	...	...	'41	...	...	...	...	...	...	1 66
...	'30	...	...	...	...	'10	...	...	...	...	...	...	'30	...	...	2 40
...	'04	...	'02	...	'06	'04	...	...	...	'08	'10	'52	...	...	...	0 86
...	...	'03	...	'02	...	...	...	...	...	...	...	...	'50	...	'05	0 60
'10	...	...	'01	...	...	'01	...	...	...	...	...	...	...	...	'26	0 72
...	...	...	...	...	...	...	...	'04	'49	'20	...	...	...	...	...	2 93
'17	...	'02	'06	...	...	...	'11	'13	...	...	...	...	...	...	...	3 02
...	'13	'13	...	...	'06	'53	...	'08	'13	...	...	...	'06	...	'11	1 32
...	...	...	...	...	...	'01	...	...	...	...	'04	'13	...	'30	...	0 62
'03	'13	...	...	...	'08	...	...	...	...	...	...	...	...	...	'06	3 16
'10	'03	...	...	...	...	...	'08	'25	'05	'03	'43	...	'10	'30	...	3 78
...	...	...	...	...	'05	...	...	...	...	...	...	...	'20	...	...	0 45
...	'15	...	...	...	'05	...	'03	'02	...	...	...	...	...	...	...	0 91
'10	...	...	...	'05	'05	...	...	'08	'04	'06	'20	'22	...	...	...	1 59
'10	...	...	...	...	...	...	...	...	...	...	'10	...	...	...	'05	0 25
...	'02	...	...	'10	'03	'05	...	...	...	'03	...	'01	'05	'04	'03	0 61
...	'03	...	'07	'08	'07	'05	...	...	'04	...	...	...	...	'10	'50	1 76
...	...	...	...	...	'13	...	...	...	...	...	...	...	...	...	'08	0 30
...	...	...	...	...	...	'07	...	...	...	...	...	...	...	...	...	2 02
...	...	...	...	...	'03	...	'55	...	...	...	...	...	...	...	...	1 06
'11	...	...	'10	...	'06	'05	'01	...	'09	'02	...	'04	...	...	...	0 88
...	...	...	...	...	...	...	...	...	...	...	...	'25	'05	...	...	0 34
'20	'40	'01	'10	'20	'29	...	'04	...	...	'04	'06	'25	'16	...	...	3 00
...	...	...	...	...	...	...	...	...	...	...	...	'16	'06	'01	'02	0 47
...	...	...	'02	...	...	'01	'09	...	...	...	...	'17	...	...	'03	0 36
'06	'34	'15	'30	'07	'01	'20	'30	'03	'02	'27	'02	...	'20	'03	'02	3 73
...	...	...	...	...	...	...	...	...	...	...	...	...	...	'11	'01	0 14
...	'01	...	...	...	'02	...	'01	'04	'03	...	'02	...	'01	...	...	1 49
...	...	'13	'14	...	'02	'01	...	...	...	'03	...	...	...	...	...	0 36
'15	'07	'04	'01	...	'23	...	...	...	...	...	...	'01	...	...	...	1 46
'08	'85	'30	'01	'02	'03	...	...	...	...	...	...	...	...	...	...	1 29
...	...	...	'06	...	...	'05	...	...	'02	...	...	...	'05	'15	'04	0 97
...	...	...	...	...	...	...	...	...	...	...	...	...	...	'02	'10	0 88
...	'06	...	...	...	'64	'06	'01	'19	'01	'04	...	...	'01	'05	'41	1 47
...	'10	'01	...	...	'06	'01	...	...	...	...	...	'01	'06	'01	'12	1 71
'18	'36	...	'07	'22	'01	...	...	...	'21	...	...	'07	...	'06	'17	2 29
'01	'72	'13	...	'41	'60	...	'52	...	'09	'07	'05	'11	...	...	'07	3 55
'01	...	...	...	...	...	...	...	...	...	...	...	...	...	'01	...	0 69
...	...	...	...	...	...	...	...	...	...	'04	...	'10	'03	'19	...	2 53
...	...	...	...	...	...	...	...	...	'17	'01	'01	...	'03	...	...	0 85
...	'17	'01	'03	'21	'03	...	'12	'49	'01	...	'14	...	'01	...	'30	1 63
'01	...	'08	'22	...	...	'18	'03	'04	'13	...	'02	'01	...	'09	...	2 28
...	'05	...	'01	'01	...	...	'08	...	'02	'41	...	...	...	...	...	1 07
...	'01	'04	'09	'38	'20	...	...	...	'01	'03	'03	'03	'06	...	'02	1 41

TABLE IV. Showing the fall of Rain on every

[illegible]

95.

the Month.

the Month.															Sums.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
...	...	...	...	...	'03	'60	'24	'21	...	'17	...	...	...	...	'04 2'47
...	'16	...	...	...	'05	'05	'26	...	...	...	...	...	...	'05	1'94
...	...	...	...	...	...	...	...	'03	...	...	...	...	...	...	0'06
...	'07	...	...	...	...	...	'30	'26	'45	...	'20	...	...	'25	2'09
'17	'13	'07	...	'30	'02	'01	'03	'12	'50	'01	...	...	...	...	2'82
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1'48
...	'02	'05	'09	'38	'12	...	...	'05	...	...	...	...	...	...	1'82
1'11	'02	...	'05	'20	...	'38	'10	...	...	'13	'19	...	...	...	2'56
...	...	...	...	...	...	...	...	'55	...	...	'50	...	...	...	1'75
'20	'70	'15	...	...	...	...	'18	'10	...	...	...	...	...	...	1'89
...	...	...	...	...	...	'15	...	'42	...	'34	'72	'10	...	...	1'75
...	...	...	...	...	...	...	...	...	'03	'10	'13	'03	...	...	0'97
...	'10	...	'44	...	...	...	'13	...	'03	...	...	...	...	...	1'16
'24	'05	'30	'43	...	'20	...	'20	'02	'11	...	...	...	...	...	2'17
'21	...	'32	...	'17	...	...	'30	'26	'31	'15	...	'13	...	'03	4'35
...	'10	...	'01	'13	'03	'03	'70	...	...	'03	'08	'04	'08	...	3'22
...	...	'35	'18	'20	...	...	'04	...	'17	'15	...	...	...	...	1'42
'10	'13	'03	'08	...	...	'01	...	'19	'01	...	'10	...	'18	'50	2'63
...	...	...	...	...	...	...	...	...	...	'09	'03	'06	'18	...	0'44
'04	...	'01	...	...	...	...	...	...	'04	'06	...	...	'46	'29	1'25
'01	'01	...	...	'01	'09	...	'38	'38	...	'01	'13	...	...	...	3'15
'02	...	'01	...	...	'10	'08	'16	'23	'25	...	...	...	'15	'05	1'10
'04	...	...	...	...	'18	...	'05	...	...	...	'03	...	'05	...	0'53
'03	'04	'17	'18	'02	'02	...	'25	'05	...	...	...	...	...	...	1'33
...	...	'20	...	...	...	'59	'18	'08	...	...	'02	...	...	...	0'09
...	...	...	...	...	'08	'05	...	'27	...	'30	'07	...	...	...	1'64
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'43
...	...	...	...	...	...	...	...	...	'16	'04	...	...	...	...	1'57
...	'01	...	...	...	...	...	...	...	'59	'58	'02	...	'20	...	0'23
...	'02	...	...	...	...	...	...	...	...	'11	...	'08	'12	...	0'44
'03	'40	'24	'01	'50	'05	'07	...	'10	'02	'05	...	'19	...	...	3'07
...	'05	'70	'04	...	'05	'26	...	'01	'05	'01	'08	...	...	...	0'68
'50	'03	'01	'15	'31	'04	'01	...	...	...	...	...	...	...	...	3'15
'02	...	...	'70	'03	'55	'03	...	...	'01	...	...	...	...	...	2'22
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2'00
...	...	...	...	...	...	...	...	...	...	...	...	...	'14	'05	1'97
...	...	...	...	...	...	...	...	...	...	...	...	...	'43	'07	0'50
...	...	...	...	'10	'25	'45	'10	'11	'80	'02	'01	...	'38	...	3'09
...	...	...	...	'03	'27	...	...	...	...	...	'13	'01	'05	'04	0'56
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'09
'09	'01	...	...	...	...	'28	'04	...	...	'27	'60	...	...	'07	1'77
...	'22	...	...	...	...	...	...	...	'07	...	...	...	'60	'10	2'34
'04	...	...	...	...	...	...	...	'39	'28	...	...	'15	...	'21	2'38
...	...	...	'03	'03	'01	'07	'06	'27	...	...	...	...	...	...	1'09
...	...	...	...	...	...	'01	...	...	...	...	'54	'02	...	...	0'90
...	'05	...	'02	...	'11	'03	...	'09	'39	...	...	...	...	...	2'84
'06	...	...	...	...	...	'01	...	...	...	...	...	...	'04	'14	0'43
...	'11	'02	...	...	...	...	...	...	...	...	...	...	...	...	0'82
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'40
'08	...	...	'28	...	...	...	...	...	...	...	...	'58	'34	...	2'44
'05	'04	...	'21	'34	'04	'04	'35	'01	...	'02	...	...	...	'19	2'16
'10	...	'14	'51	'63	'02	'16	'01	...	...	'12	...	...	...	...	2'08
'13	'33	'02	...	...	...	...	'20	'03	...	...	...	...	...	...	1'01

TABLE IX. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	...	...	'03	...	'01	...	...	...	...	...	...	...	...	...	...
1816.	'15	'20	...	'40	'02	...	'06	...	'19	'31	...	'10	...	...	...
1817.	...	...	...	...	...	...	...	...	...	...	'01	'06	'03	'31	'02
1818.	...	'01	...	'02	'42	'70	...	...	'08	'15	...	...	...	...	...
1819.	'01	...	'12	'23	'22	'04	...	...	...	...	...	...	...	...	...
1820.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1821.	'42	'40	'03	...	...	...	'04	'10	...	'50	...	'08	'42	'15	...
1822.	...	'04	...	...	...	'02	...	...	...	...	...	...	'02	...	...
1823.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'08
1824.	...	...	...	'12	...	...	...	'70	...	'43	'60	'40	...	...	...
1825.	...	...	...	...	...	...	...	'15	...	...	...	...	...	...	...
1826.	'11	...	...	'26	'07	'56	'23	'13	'49	...	...	...	...	...	'15
1827.	...	...	...	...	...	...	...	...	...	'80	...	'17	'42	...	...
1828.	...	...	...	'06	...	...	...	...	'16	...	'20	'47	'02	...	'38
1829.	...	'11	...	...	...	...	'28	'35	...	'26	'04	...	...	'71	...
1830.	...	...	'03	'26	...	'28	'13	...	'33	...	'30	'13	'06	'07	'36
1831.	'16	'02	...	'03	'61	'15	'25	'11	...	...	...	...	...	...	...
1832.	'09	...	...	...	...	'11	...	...	'13	...	...	'02	...	...	...
1833.	...	'01	'11	...	...	...	...	'13	...	'15	'18	...	...	...	'01
1834.	'31	'01	...	...	...	...	...	'45	...	'39	'16	...	...	...	...
1835.	...	...	'20	'16	...	...	...	'18	'34	'30	'05	'02	'10	...	'20
1836.	'02	'15	...	...	'68	'21	'12	...	...	...	...	'44	...	...	...
1837.	'12	'15	'08	'12	'04	...	'19	'02	...	...	'25	'06	'08	...	...
1838.	...	...	...	...	...	'53	'07	...	...	...	...	...	...	...	...
1839.	'12	...	'20	'15	'05	...	...	...	...	'05	'03	...	...	'98	'12
1840.	...	...	'22	'45	...	...	'02	...	...	'02	...	...	...	'16	...
1841.	...	...	'09	'42	...	...	...	...	...	...	...	...	...	...	...
1842.	'25	...	...	...	...	...	'27	'50	...	'09	...	...	...	...	...
1843.	...	...	...	...	...	...	...	...	...	'10	...	...	...	...	...
1844.	...	...	...	...	...	'19	...	'30	'13	...	...	...	...	'01	'01
1845.	...	...	...	...	'03	...	...	...	...	...	...	...	...	'08	'05
1846.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1847.	...	...	'05	'05	...	...	'05	'10	...	...	...	...	'15	...	'13
1848.	...	...	...	...	...	'07	...	...	...	'28	'05	...	...	...	...
1849.	'52	'20	...	'42	'01	...	...	...	...	...	'05	'44	'14	...	...
1850.	'04	...	'04	...	...	...	...	...	...	...	...	...	...	...	...
1851.	...	'12	'01	'01	...	...	...	...	...	...	...	...	...	...	...
1852.	...	...	...	...	'01	'01	'26	'97	'04	'11	...	...	...	...	'10
1853.	'48	'30	'20	...	'03	...	...	...	'12	'02	...	...	'08	'01	'13
1854.	...	...	...	...	...	...	...	...	...	...	...	'09	'03	'30	'02
1855.	...	...	...	...	...	...	...	...	...	...	...	...	'22	'24	...
1856.	'02	'06	...	...	...	...	'23	...	...	...	...	'05	'13	...	...
1857.	'17	'19	'20	'24	...	...	...	1'00	'03	...	1'16	'05	...	'25	...
1858.	...	...	'04	'15	'21	...	'04	'05	...	...	...	...	...	...	...
1859.	...	'19	...	...	...	'26	...	'01	'09	...	...	...	'15	'29	'26
1860.	'11	...	'01	...	...	...	...	...	...	'10	...	...	...	...	'03
1861.	...	'04	...	...	...	'07	...	...	'07	...	...	...	'07	'01	'02
1862.	...	'03	'22	...	'13	'01	...	...	...	'36	...	...	...	'06	...
1863.	...	'04	'01	'37	'24	'15	'31	...	'07	'40	...	...	...	...	...
1864.	...	'05	'11	'02	'09	'25	...	'03	...	...	'02	...	...	'21	'18
1865.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1866.	...	'90	...	'24	'14	'18	...	'45	'17	'03	'15	'01	...	'44	'07
1867.	...	...	'72	...	'60	'14	...	...	'47	'15	'04	'46	...	'05	...
1868.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1869.	...	...	...	...	'04	'13	'12	...	...	'40	...	'42	'32	'09	'18

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

105

Day in SEPTEMBER during the Years from 1815 to 1869.

the Month.															Sun.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
...	'10	...	...	...	...	...	'18	'05	'21	...	'09	'12	'16	'12	1'07
...	...	...	'01	...	'01	...	...	'03	...	...	'03	...	'33	'02	1'86
...	...	'04	'03	...	...	...	...	'03	...	'13	'04	'09	...	'02	0'81
'13	'14	'01	'02	...	'08	'02	'07	'16	...	1'30	'20	'06	...	'21	3'78
'50	...	...	...	...	...	...	...	...	'13	'26	'12	'40	1'00	'10	3'13
'03	...	1'38	...	...	'50	'03	...	'05	...	...	'11	'11	'02	'02	2'23
...	'07	...	...	...	...	'73	'03	...	'02	...	'11	...	'30	...	3'40
...	...	...	...	...	...	...	'26	'36	'67	...	...	...	...	...	1'37
...	'07	...	...	...	...	'34	...	'24	...	...	'01	...	...	'15	0'89
...	...	...	...	'37	...	'08	...	'15	'10	'04	'20	'02	...	...	3'21
...	1'37	'28	...	...	...	'20	...	...	...	'56	...	...	...	...	2'56
...	...	'15	'22	...	...	...	...	...	...	'44	'26	...	...	...	3'07
...	...	...	...	'38	...	'10	'16	'33	'15	...	'45	...	...	'55	3'51
...	...	...	...	...	...	...	...	...	...	'62	'20	'25	'05	'05	2'41
'68	'07	'52	'01	...	'19	...	...	...	...	...	'05	...	...	...	3'27
...	'23	...	'35	'11	'15	'35	'04	'05	...	...	'31	...	...	...	3'54
...	...	'14	'20	...	...	...	...	...	...	...	'04	'09	'04	'31	4'15
...	...	...	...	...	...	...	...	...	...	...	...	...	'01	'10	0'46
'16	'23	'03	'15	...	...	'09	'21	...	...	'06	'39	...	...	...	1'91
...	...	'04	...	...	...	...	...	'06	'54	'14	...	...	...	...	2'10
...	...	'98	'11	...	'51	'43	'17	...	'51	'04	'01	'01	'11	'11	4'43
...	...	...	'17	...	'06	...	'05	...	'65	'30	...	...	...	...	2'85
...	...	...	...	...	...	...	...	...	'03	...	...	...	...	...	1'14
...	...	...	...	'08	...	'05	'68	'08	...	1'10	...	'03	...	...	2'62
'25	'65	'80	'10	'68	'05	'10	...	'03	'05	'05	...	...	...	...	4'46
'15	'16	...	...	...	...	'60	...	'16	'26	...	'15	'25	...	...	2'60
'02	...	...	'09	'09	'23	1'03	'30	'19	'42	'31	'06	'26	'05	'05	3'76
...	'39	'29	'03	'05	'01	...	'46	'21	'33	'19	'25	'02	'02	'02	3'36
...	...	'11	...	...	...	...	...	...	...	...	...	...	'17	...	0'38
...	'54	...	'01	...	...	...	...	...	...	...	...	...	...	...	1'19
'39	'66	'04	...	'08	'79	...	...	...	'01	'01	'04	...	...	...	2'18
...	...	...	...	...	'35	1'18	...	...	'01	'19	...	...	...	...	1'73
'05	'10	'01	'40	'10	'08	...	...	...	...	...	...	...	...	...	1'27
...	...	...	'01	'01	'01	...	'12	'30	'01	'47	...	'75	'35	'01	2'44
...	...	...	...	...	'11	...	'10	'01	...	'01	'22	'15	'20	'58	3'16
...	...	...	'05	'22	'08	'01	'23	'10	...	'20	'11	...	'05	'17	1'30
...	...	...	...	...	...	...	...	'09	'01	...	'05	...	...	'14	0'43
...	...	'75	'22	'25	'10	...	...	...	...	...	'94	'17	...	...	3'93
'35	...	...	...	...	...	'01	'18	'13	...	...	...	...	'25	'11	2'40
'01	...	...	'07	'11	'04	...	'03	...	...	...	...	...	...	...	0'70
...	'05	...	...	...	...	...	...	...	...	...	...	'17	'20	'24	1'12
...	'06	'19	...	...	'20	'20	'02	'35	'02	'18	'64	'30	'06	'10	2'81
...	...	...	...	...	'08	...	'10	'28	...	...	'17	...	...	...	3'92
...	'03	'10	'17	...	'03	...	...	...	...	...	...	...	...	'06	0'88
'11	...	...	'24	...	'29	...	'11	...	'03	1'26	'26	'01	'03	'12	3'71
'08	'18	'28	'03	...	'11	'19	'04	'26	'36	'07	'21	'11	'02	...	2'19
'01	...	...	...	'03	'19	'14	'28	'21	'28	...	...	'01	'06	...	1'49
...	...	...	...	'01	...	...	...	...	'13	...	'03	'03	'38	'22	1'61
...	...	...	'69	'01	'06	'04	'37	...	...	...	'21	...	...	...	2'97
'26	'57	'35	...	...	'16	...	...	...	...	...	...	...	...	...	2'76
...	...	...	...	...	'19	'49	...	'02	...	'05	'16	...	...	...	0'16
'16	'03	...	'02	...	'19	'49	...	'03	...	...	...	...	...	...	3'90
...	'14	'02	...	...	...	'10	'03	...	...	...	...	...	...	...	2'92
...	...	'27	...	'02	...	...	...	'01	'43	'05	'28	'02	'12	'32	1'52
...	'10	'74	'11	...	'01	...	...	...	...	...	...	...	...	'42	3'08

TABLE X. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	'18	'06	...	...	...	'29	'01	...	...	...	...	'47	...	'01	...
1816.	'46	'11	'10	'15	'01	'01	'41	'18	...	...	...	...	...	...	...
1817.	'03	...	...	...	...	...	...	...	...	...	...	...	'03	'02	'01
1818.	'05	'03	...	'73	'40	'12	'08	...	...	'02	...	'28	...	...	...
1819.	...	...	...	...	'06	...	'01	...	...	...	...	...	...	...	...
1820.	'08	...	...	...	...	...	...	...	...	...	'05	...	...	...	'22
1821.	...	...	...	'26	'64	...	...	'22	...	...	...	'10	...	...	'14
1822.	...	...	...	'40	'10	...	'34	'28	'01	'22	...	...	...	'39	...
1823.	'15	'31	...	...	'11	...	'11	...	'20	...	'32	...	'10	...	...
1824.	'32	...	...	'17	'10	'12	'45	'15	...	'10	'60	...	'02	...	...
1825.	...	'60	'31	'04	'20	...	'56	...	...	...	...	...	...	...	...
1826.	'05	...	...	...	...	...	...	...	'12	'26	...	'06	...	...	...
1827.	...	'20	...	...	...	...	...	...	'36	...	...	'90	...	'08	...
1828.	'52	...	...	'14	...	'25	...	...	...	...	'06	...	...	...	...
1829.	...	...	'62	...	...	'15	'48	'22	...	...	...	...	...	...	...
1830.	'06	'20	'15	...	...	...	...	...	...	...	...	...	...	...	...
1831.	'01	'14	'53	'21	...	'03	'03	'41	'27	'04	'19	'28	'23	...	...
1832.	'28	...	'17	'42	'25	'37	'47	...	'18	'03	...	'15	...	...	'06
1833.	...	...	...	...	...	...	...	...	...	...	...	'13	'26	'12	'28
1834.	...	...	...	...	...	...	...	...	...	...	...	...	...	'59	'03
1835.	'91	'24	'66	'01	...	...	...	'05	'29	'26	...	'15	...	...	'01
1836.	'38	'55	...	...	...	'80	'20	...	'38	...	...	'06	'15	...	'28
1837.	...	...	'06	...	...	'45	...	'06	...	...	...	...	...	...	...
1838.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'10
1839.	...	...	'07	'23	'10	...	...	...	...	...	...	'25	'05	...	...
1840.	...	...	...	...	'11	...	...	...	...	...	...	...	...	...	...
1841.	'44	...	'38	'37	'27	'02	'07	'05	...	'29	'57	'21	...	...	'49
1842.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1843.	...	'12	...	...	...	'31	'11	'37	'01	'42	'30	'03	...	...	...
1844.	...	...	...	...	'20	...	...	...	...	'01	...	'03	'12	'21	'38
1845.	'01	'04	'04	'01	...	'39	'04	...	'43	'30	...	...	...	...	...
1846.	...	'51	...	'06	'09	'10	'02	'06	'20	...	'16	...	'07	'31	'95
1847.	...	...	...	...	...	'23	...	'03	'18	...	...	...	...	...	...
1848.	...	'03	'12	'11	...	...	...	...	'13	'01	...	'01	'02	'25	'09
1849.	'08	'02	'55	'75	'02	'20	'55	'01	...	...	...	'03	'15	'14	...
1850.	...	'03	...	...	...	'10	...	...	...	'06	'15	...	...	...	...
1851.	'17	'20	'05	'05	...	'25	'05	...	'12	...	...	...	...	'02	'45
1852.	'13	'07	'01	'01	'07	...	...	...	'03	...	...	...	...	...	...
1853.	'20	...	'01	'20	'43	'02	'08	'29	'02	'01	'01	'58	'05	'17	'10
1854.	...	'01	...	...	...	'60	'12	'01	'01	...	'06	...	...	...	'14
1855.	'10	'02	'15	'30	'42	'15	'16	'01	...	'07	'05	'10	...	'01	'07
1856.	'01	...	...	'07	'10	'02	'05	'33	...	...	'30	...	...	...	'30
1857.	...	...	...	'10	'05	...	'20	'47	'01	...	'19	...	...	...	...
1858.	...	...	...	...	'25	...	'19	'09	...	'10	...	...	'03	'04	...
1859.	'01	...	...	...	'01	...	'04	'27	'01	'19	'49	'26	'01	...	'01
1860.	...	...	...	...	...	...	...	...	...	'21	'17	...	'01	...	'18
1861.	'09	...	...	...	'03	'08	...	...	'04	...	'43	...	...	...	...
1862.	...	'01	...	...	'14	'36	...	...	...	...	'72	'36	'02	'02	'01
1863.	'52	'01	'04	...	'04	...	'15	'06	'06	'13	'02	...	'08	...	'14
1864.	...	'01	...	...	...	...	...	...	...	...	...	...	...	...	...
1865.	...	...	...	...	...	...	...	'10	'44	'18	'15	...	...	'02	'09
1866.	...	...	...	...	...	'02	...	...	...	...	...	...	...	'01	...
1867.	...	'05	...	...	...	'01	'25	'02	'36	...	'04	'04	'02	'02	'32
1868.	...	...	'43	'04	...	'11	'44	...	...	...	...	...	...	...	'01
1869.	'11	'28	'02	...	...	...	...	...	...	...	...	...	'12	...	'01

Mar.]

GLAISHER—DAILY RAINFALL, 1815-69.

107

Day in OCTOBER during the Years from 1815 to 1869.

the Month.																Sums.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
...	'01	...	'28	'01	...	...	'01	'36	'10	...	...	'50	'10	...	...	2'39
'01	...	'10	...	'15	...	'08	...	'04	'05	'40	...	...	...	'10	...	2'61
'13	'70	'10	'20	'10	'04	...	'01	'13	'04	...	...	'20	'28	'13	'24	2'39
...	...	'01	...	'01	...	...	...	...	'12	...	...	...	...	...	'04	1'89
...	...	...	...	...	'27	'40	'03	...	...	...	...	'08	'10	'27	'91	2'13
'25	'24	...	...	'35	'10	'22	'20	'12	'40	'14	'10	...	'07	'10	...	2'64
...	...	...	...	'61	...	...	...	'21	'01	'04	...	'18	...	...	'01	2'42
...	...	...	1'16	'17	...	...	...	...	'33	...	'13	...	...	...	'07	3'60
'01	...	...	...	'10	...	...	...	...	...	...	...	...	'20	'20	1'15	3'96
...	...	'07	...	...	...	...	...	...	...	'10	...	...	...	'24	...	2'44
...	...	...	'36	'40	...	...	...	...	'08	...	...	...	...	'10	'04	2'69
...	'10	...	'04	...	'03	...	'45	...	'33	'03	...	'22	...	...	'05	1'74
...	...	...	'25	'53	...	'09	'42	...	'10	...	...	...	...	'94	...	3'87
...	...	...	...	...	...	...	...	'32	...	...	...	'12	...	...	...	1'41
...	...	...	...	...	...	'20	...	...	...	...	...	...	...	...	...	1'67
...	...	...	'03	...	'01	...	...	'14	'45	...	'06	'02	...	'02	...	1'14
'01	...	...	...	'20	'01	...	'41	...	'15	'12	'38	...	...	...	...	3'65
...	...	'14	...	...	...	...	...	...	...	'07	'10	'20	'01	'51	'41	4'41
'08	...	'09	...	'05	'68	'78	...	...	...	'08	'24	'03	...	...	'05	2'87
'08	'10	...	'19	'01	'03	...	'16	...	...	...	'01	...	...	...	...	1'20
...	...	...	...	'08	...	'41	'42	...	1'14	'02	...	'39	'04	1'00	'01	6'09
...	...	...	'15	...	...	...	...	...	...	...	...	'89	...	...	...	3'84
...	'02	...	...	...	...	...	...	'50	'30	'09	'08	'59	'06	'05	...	2'26
'11	...	'05	...	'04	...	...	...	'08	...	'07	'45	'40	...	'50	...	1'80
'05	...	'30	'02	...	...	...	...	'50	...	...	'06	'03	...	'07	...	1'73
...	'06	'10	'10	...	'02	'03	...	'26	...	...	'28	'08	'17	'25	'02	1'48
'05	...	'50	...	...	'06	'27	'06	...	'03	'03	'10	'09	'18	'31	'58	5'84
...	...	...	'37	...	...	'46	...	...	'08	'36	...	...	...	...	...	1'27
'20	'03	...	...	'25	...	'10	...	'46	...	...	'13	'01	'09	'47	'97	4'38
'01	...	...	'01	'01	'76	...	'01	'94	'02	'04	...	...	'26	...	...	4'01
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1'26
'42	'39	'38	'12	...	...	'21	'20	'10	'06	...	...	...	'06	...	...	4'47
...	...	'23	'05	'20	...	'02	'25	'02	...	...	'25	...	...	...	...	1'46
'03	'01	'01	...	'56	'11	'17	'23	'16	'12	'01	'42	'24	'35	'17	'09	3'45
...	'05	...	...	'05	'17	'02	...	'01	'05	...	'04	...	...	...	...	2'89
...	...	...	...	...	...	...	'74	'15	'01	...	...	'01	...	...	...	1'25
'01	...	...	...	...	...	...	...	...	...	...	...	...	'36	'02	...	1'75
...	...	...	...	...	...	'35	'07	'09	'92	'46	'17	'01	'20	'16	...	3'75
'12	'20	'01	'59	'08	'02	'08	'03	...	...	'19	'05	'16	'03	...	'01	4'74
'16	...	'01	'02	'47	'01	...	'10	'18	'62	'16	...	'01	...	...	...	2'69
...	'45	...	'01	...	...	'03	...	...	'05	'47	'05	...	'60	1'06	'60	4'93
'06	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'34	1'58
...	...	'28	...	...	...	2'57	...	...	...	...	...	...	'06	...	...	3'93
...	...	'24	'14	...	...	...	...	...	...	...	...	'28	...	...	...	1'36
'13	'47	'01	'02	'05	'04	...	...	'11	'60	'02	'01	'13	...	'25	'02	3'16
'30	'01	'09	'01	'01	...	...	...	...	...	'04	'01	...	'01	...	'01	1'06
...	'01	...	...	...	'01	'16	'01	...	'03	...	...	...	...	...	...	0'89
...	'26	'94	...	'58	...	...	'12	...	...	'30	'04	'07	...	...	'13	4'08
'05	'02	...	...	'03	...	...	...	...	...	...	...	'03	'12	'32	...	1'82
...	'06	...	...	'02	...	'50	'11	...	...	...	'34	...	...	'02	...	1'06
...	'34	'46	1'06	...	'14	1'11	'19	'10	...	'72	'06	'02	'13	'45	'14	5'90
...	'79	'03	'02	'07	'19	...	...	...	'87	...	...	'05	...	'04	...	2'09
'26	'03	'06	...	'01	...	...	'01	...	...	...	'49	'02	'05	'05	'02	2'14
'02	...	...	'01	...	'16	...	'15	'17	'21	'44	...	...	'40	...	...	2'59
'12	...	'89	'01	...	...	...	...	'09	...	'05	...	...	...	'07	...	1'77

TABLE XI. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	...	...	...	...	...	...	'23	'02	'44	'02	...	'06	'46	'07	...
1816.	'30	'13	'61	'10	'08	'11	'07	'02	'25	'08	'01	'32	'03	...	...
1817.	'07	...	'02	'01	'01	'01	'02	'19	'10	'03	'03	'13	'04	'18	'54
1818.	'20	...	'04	'01	'05	...	'04	...	...	...	'59	'02	...	'25	'32
1819.	'17	...	...	...	...	...	...	'34	...	'20	'18	...	'10	...	'03
1820.	'05	'02	...	...	...	'22	...	...	...	...	...	...	'25	'13	'03
1821.	'03	...	'18	'34	'05	...	...	...	...	...	...	'58	...	'11	'15
1822.	...	...	...	...	...	'03	...	...	...	'22	...	'02	...	'30	'32
1823.	'09	...	...	'01	'28	...	'42	'15	...	...	...	...	...	...	...
1824.	'30	...	'05	...	...	...	...	...	'11	'02	...	'77	...	'20	...
1825.	...	'09	...	'11	...	...	'07	...	'60	...	...	'77	...	...	...
1826.	'04	...	...	'83	...	'40	'06	...	...	...	'16	...	...	'55	...
1827.	...	'04	...	...	...	...	...	...	...	...	...	...	...	...	'45
1828.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'42
1829.	...	...	...	...	...	...	...	...	...	...	'95	...	'21	...	...
1830.	...	'03	'14	...	'18	'69	...	...	...	'29	...	...	'39	'04	'01
1831.	'58	'04	'04	...	'01	'14	'03	'04	...	'20	...	...	...	'11	...
1832.	...	'24	...	...	'09	...	'01	'19	'02	'66	'10	...	'03	'78	'11
1833.	...	...	...	...	'11	...	'79	'09	...	'06	'10	...	...	...	...
1834.	...	...	...	'03	'28	'28	'14	'34	'39	...	...	...	...	'01	...
1835.	...	'40	'18	...	...	...	'30	...	...	...	...	'07	...	'01	...
1836.	...	...	'18	...	...	...	...	...	...	'36	'15	...	'31	...	...
1837.	'28	'19	...	...	...	...	...	...	...	'11	...	...	...	'26	'05
1838.	'20	'04	'08	...	...	'25	...	'28	...	...	...	...	...	...	'02
1839.	'40	...	'30	'06	...	...	'15	'05	...	'35	...	...	'02	'02	...
1840.	...	...	...	'02	'11	'28	'28	'18	...	'25	'10	...	'18	'05	...
1841.	'08	...	...	...	...	...	...	...	...	...	'38	...	'27	...	...
1842.	...	'02	...	...	'03	'01	...	...	...	...	'03	'30	'43	'18	'52
1843.	...	'11	'02	...	...	'17	'02	'03	'01	...	...	...	...	'16	'02
1844.	'70	'64	'01	...	'06	'20	'24	'03	'28	'34	'20	'66	'28	'10	...
1845.	...	...	...	...	...	'05	...	...	...	'01	...	...	...	...	'05
1846.	...	...	...	'01	...	...	...	...	...	...	...	...	...	...	...
1847.	...	...	...	...	...	'25	...	...	...	...	'06	...	...	...	...
1848.	'08	'17	'02	'01	'01	...	'01	...	...	'01	'08	'04	...	...	...
1849.	...	...	...	'07	...	...	'06	...	...	...	...	...	'10	'30	'15
1850.	...	...	...	'19	...	...	...	...	...	...	...	...	...	...	...
1851.	...	'09	...	'02	...	'01	'05	...	'03	'16	'01	...	...	...	...
1852.	...	'45	'28	...	'01	'10	'20	...	...	...	'27	'82	'01	'35	'32
1853.	...	...	'02	...	...	'06	...	...	...	...	...	...	'02	...	'08
1854.	...	...	...	...	...	...	...	...	...	'05	'03	...	...	'02	'20
1855.	...	'27	'50	...	'01	'01	'02	'21	'01	'07	'01	...	...	...	...
1856.	...	...	...	'01	'01	...	...	'21	...	'04	'04	'01	...	...	'03
1857.	...	'05	'02	'40	...	'02	...	...	...	...	...	...	...	...	...
1858.	...	...	'01	...	'02	...	...	...	...	...	...	...	...	...	...
1859.	'06	'25	'01	'26	'21	'47	'06	'01	...	'01	...	...	...	...	'01
1860.	...	...	'01	'01	...	...	...	'01	'01	'14	...	...	...	'11	'24
1861.	'15	'21	...	'05	'57	'19	...	...	...	'53	...	'15	'29	'54	...
1862.	'01	...	...	...	'53	'11	'05	...	'13	'05	...	...	...	...	...
1863.	'01	'59	'02	'02	'09	'04	'09	'25	...	'08	...	...	...	...	...
1864.	...	...	...	...	...	...	...	...	...	...	...	...	'11	'36	'09
1865.	'01	...	'19	...	...	...	'01	'12	'02	...	...	...	...	...	'02
1866.	...	'03	'08	...	'01	...	...	'31	...	...	'29	'05	'22	...	...
1867.	'04	...	...	...	...	...	...	...	...	...	...	...	...	'08	...
1868.	...	'03	...	'15	...	...	...	'03	'02	...	'01	...	...	...	...
1869.	...	...	'04	'05	'19	...	...	...	'07	'01	...	...	...	...	'10

Day in NOVEMBER during the Years from 1815 to 1869.

the Month.															Sum.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	ins.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'03	...	...	...	...	...	...	...	...	'02	...	'01	...	...	'01	1'37
...	...	'06	...	...	'15	'01	...	...	...	'30	'08	...	'02	'01	2'74
'12	'01	'01	...	...	'03	...	...	'03	'08	'12	'02	...	...	...	1'80
'34	...	...	...	...	...	...	'12	'27	'01	'15	'08	...	...	...	2'49
'82	'40	'09	...	...	...	'13	...	...	...	...	'10	...	'13	...	2'69
...	'04	'23	...	'03	...	'10	'35	'11	...	'20	...	...	...	...	1'76
...	'35	'90	'17	'05	'11	'16	'04	'15	'01	'12	'45	...	'10	'28	4'33
1'12	...	'29	...	'33	'21	...	'30	...	'09	'07	'03	'08	'13	'12	3'66
...	...	'06	...	...	...	...	...	...	...	'45	...	...	'45	'09	1'55
'06	...	...	'50	'51	'22	'39	...	'35	...	'02	...	...	'13	'25	3'88
...	...	...	'20	...	...	'16	...	...	'22	...	...	'17	'46	...	2'85
...	'04	...	...	...	...	...	...	'16	...	...	...	...	'22	...	2'46
...	'15	...	...	...	...	...	...	...	...	'20	...	...	'33	...	1'17
...	'30	...	'13	...	...	...	...	...	...	...	...	...	...	...	0'85
...	...	...	...	...	...	...	...	...	...	...	'16	...	...	...	1'32
'71	...	'01	...	'04	'05	'04	...	...	...	...	'36	'01	...	'01	3'00
'31	...	'09	...	'69	'26	'08	...	...	...	...	...	...	...	'08	2'70
...	...	...	...	...	...	...	...	'79	'43	...	'38	'23	...	'42	4'48
...	...	...	...	...	...	'08	...	'25	...	...	'03	'94	...	'06	2'51
...	...	...	...	...	'16	...	...	...	...	...	'24	...	'50	'23	2'37
...	...	...	...	...	...	'22	...	...	'05	'24	'34	'04	'73	'01	2'59
...	...	'20	...	...	...	...	'21	...	...	...	'30	'10	'38	'38	2'19
...	...	'26	...	'05	'08	'04	...	'20	...	'02	...	...	...	...	1'54
...	...	'68	'10	...	'16	...	...	...	...	'05	'65	'40	...	'20	2'91
...	...	'12	'30	'05	'20	'03	...	'04	'16	...	1'20	'12	'20	'25	4'02
'10	'10	'12	'40	...	'17	'04	...	...	...	...	...	...	...	'04	2'62
...	'21	'06	'20	'12	'01	...	...	...	...	'07	'68	'35	'12	'25	3'75
'25	...	...	'01	'62	...	'41	'10	'36	...	'05	'23	'06	...	'12	3'61
...	'02	...	'10	...	...	'53	...	'21	'22	...	...	...	...	'12	1'74
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4'74
'10	'13	'01	'07	'19	'74	...	'03	...	'04	...	...	'02	'35	'01	1'80
...	'01	...	...	...	'46	'08	'10	'50	'20	...	...	...	...	...	1'36
'12	...	'03	'01	'01	'06	'08	'07	'04	...	'03	'01	'50	...	'10	1'15
...	...	'03	...	...	...	...	'17	'17	'01	...	...	...	...	'57	1'63
'09	...	'39	'10	'15	'06	'20	'12	'64	'02	'01	'01	...	...	...	1'98
...	...	...	...	...	'01	...	'19	...	...	'01	...	...	...	...	0'58
'37	'04	'28	'25	'16	'15	'11	'13	'05	'02	1'00	...	'29	...	...	5'66
'03	...	...	...	'22	...	...	'33	'28	'42	...	...	...	'03	'02	1'51
'27	'13	...	...	...	'19	...	'01	...	'02	...	...	'15	'17	'17	1'41
'01	...	...	'06	'05	'01	...	...	'05	...	'01	'01	'01	...	...	1'32
...	...	...	'15	...	...	...	...	'47	'05	...	...	...	...	...	1'02
...	...	...	...	...	...	...	'15	'50	'10	'03	...	...	...	...	1'27
...	...	...	...	...	...	...	...	...	...	'02	'21	'16	'02	'01	0'45
'01	...	...	...	'01	'01	'01	...	...	'01	'08	'07	'55	'10	'38	2'58
...	'52	...	...	'22	'08	...	...	'02	'17	'02	...	'13	'18	'18	1'87
...	'01	...	...	'01	'01	1'00	...	...	...	'06	...	...	'10	'20	5'06
...	...	...	'01	...	...	...	...	...	...	...	'10	...	...	...	0'99
...	...	...	...	...	'13	...	...	'25	...	...	...	...	...	...	1'57
...	'28	'03	...	...	'05	'19	'18	'86	'04	'11	...	'03	...	'24	2'57
...	'37	...	'18	'19	'15	'32	'05	'01	'08	'30	...	'28	'04	'05	2'39
'02	...	'38	'02	...	...	...	'04	'01	'02	...	...	...	...	...	1'48
'02	...	...	...	...	...	...	...	...	...	'01	...	...	...	'27	0'42
...	'01	...	'03	...	...	'66	'13	...	'01	'06	...	'02	...	...	1'16
...	...	...	...	...	...	'51	...	...	...	...	'65	'42	'15	'19	2'38

TABLE XII. Showing the fall of Rain on every

Years.	Days of														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1815.	'05	'02	'08	'09	'01	'30	'07	'10	...	...	...	...	'01	'01	'02
1816.	...	...	...	'09	...	'10	'12	'31	'06	'10	'12	'10	'20	'02	'60
1817.	'18	'34	'02	'05	...	'24	...	'17	'31	...	...	...	'07	...	'45
1818.	...	'20	'08	...	'01	...	'08	'18	'01	'54	'03	...	'06	...	...
1819.	'35	...	...	'55	'30	...	...	...	...	...	...	...	...	...	'12
1820.	...	...	...	...	...	...	...	...	...	'06	...	'21	'50	'25	...
1821.	...	...	...	'55	'20	'13	...	...	'03	...	'10	...	...	...	...
1822.	...	'34	'50	...	'51	'77	...	...	...	'08	...	...	...	...	...
1823.	'18	'20	'15	'10	...	'46	...	...	...	...	...	...	...	...	...
1824.	'33	...	'40	'08	'61	...	'22	...	'07	'20	...	...	...	'01	...
1825.	...	'55	...	...	'68	'41	...	...	...	'07	...	...	'17	'36	...
1826.	...	...	...	'06	...	'45	'05	'20	...	...	'21	'04	'19	...	...
1827.	...	...	'35	...	...	...	...	'20	...	...	...	'80	'12	...	'22
1828.	...	...	...	...	...	...	'44	'35	'43	...	'18	...	...	...	...
1829.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1830.	...	...	...	...	'10	...	'03	'45	'11	...	'01	...	...	...	'13
1831.	...	...	'01	'01	'07	'07	'18	'46	'19	'09	'65	'45	...	...	'13
1832.	'06	'06	...	...	'20	'01	...	...	...	...	...	...	'02	'05	'33
1833.	'06	...	'03	'09	'06	'19	'15	'19	'03	'01	'04	...	'01	...	'04
1834.	...	...	...	...	...	'08	...	...	'24	...	...	...	...	'01	...
1835.	...	'04	'01	'03	'01	...	...	'13	...	...	...	...	...	...	...
1836.	...	'29	...	...	...	...	...	'55	...	...	...	'20	'05	...	'17
1837.	'08	...	...	...	...	'25	'08	'05	'02	...	...	'05	...	...	...
1838.	'12	'60	'06	...	...	...	'20	...	...	...	...	...	...	'03	...
1839.	...	...	...	...	'03	...	...	...	'05	...	'08	'05	'25	...	'10
1840.	...	...	...	...	...	...	...	...	'04	...	...	...	...	...	...
1841.	'20	'07	'08	'13	'11	'22	'14	...	'05	'04	'17	'07	'09	...	'04
1842.	...	...	...	...	...	...	...	...	...	...	...	'29	...	...	...
1843.	...	'02	...	...	...	...	...	...	'15	...	...	...	...	...	...
1844.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'01
1845.	...	'23	...	'40	...	...	...	'10	...	...	...	...	...	...	...
1846.	...	...	...	...	...	...	...	...	'02	...	...	...	...	...	...
1847.	...	...	'20	'40	'32	'06	...	'02	...	'05	...	...	...	...	...
1848.	'24	'01	'01	'21	'21	'12	'14	'05	...	...	...	...	...	'16	'08
1849.	'02	'40	'41	...	'17	'04	...	'30	...	'12	'01	...	...	'18	'08
1850.	'02	...	...	'05	...	...	...	...	...	...	'01	'04	...	'38	'25
1851.	...	...	...	'01	'02	...	...	...	...	...	...	...	...	...	...
1852.	'01	'03	...	...	'03	'15	'10	'19	'11	'02	'01	'03	'17	'06	'17
1853.	...	...	...	'01	...	...	...	...	'08	'04	...	...	...	...	'02
1854.	...	...	...	...	'10	...	'01	'07	'03	...	...	'01	'03	'01	...
1855.	...	'05	'01	'01	...	...	...	'16	...	...	...	...	...	'07	...
1856.	...	...	'15	'10	...	'05	'04	...	'03	'14	'15	'35	'07	...	...
1857.	'05	...	'05	...	...	...	...	...	...	...	...	...	...	...	...
1858.	'12	'04	...	'09	...	...	...	...	...	...	...	...	'07	...	...
1859.	...	'02	'02	'06	'27	'07	'01	...	'01	...	'01	'05	...	'01	...
1860.	...	'03	'15	'06	'01	'06	'01	'35	'11	...	'02	...	...	...	'02
1861.	...	...	...	...	'32	'27	'15	'25	'01	...	'04	...	'07	'02	...
1862.	'05	...	...	'04	'03	'12	...	'27	'04	'22	'14	...	'14	...	...
1863.	'04	'30	'43	...	'01	'04	...	...	'13	...	...	...	...	...	...
1864.	...	...	'01	...	...	...	...	'14	...	...	'01	'01	...	'01	...
1865.	'05	...	'01	'03	'01	'01	'16	...	...	...	...	...	...	...	...
1866.	...	'29	'06	'10	'21	'34	'03	...	'05	...	...	'13	'22	'06	'15
1867.	'67	'18	...	...	'23	'03	'03	'20	...	...	'02	...	'10	'26	...
1868.	'05	...	'07	'16	'03	'34	'45	'50	...	...	'01	...	'02	'13	'36
1869.	...	...	'04	...	...	...	...	...	...	'12	'31	'01	'08	'06	'34

Day in DECEMBER during the Years from 1815 to 1869.

the Month.																Sum.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ins.
'09	'04	...	...	'50	'33	...	'01	...	...	'02	'21	'02	'07	...	...	2'05
...	'18	'05	'01	...	...	...	'03	'02	'04	...	'20	'03	'15	'12	'26	2'91
'95	'20	'30	'03	'08	...	...	...	...	...	...	'09	'05	...	...	...	3'53
...	...	'01	'12	...	...	...	...	...	...	'02	...	...	...	...	...	1'34
'01	'51	'56	...	'18	...	'50	'40	...	...	...	...	...	...	...	...	3'48
...	'34	...	...	...	...	'15	'06	...	...	...	...	...	...	...	...	1'57
...	'20	'25	'21	'05	'18	'02	'23	'10	'91	'10	'30	'32	'70	'14	...	4'72
...	...	...	'06	...	...	...	...	...	...	...	...	...	...	...	...	2'26
...	'11	'27	'06	...	...	...	...	...	...	'53	'17	...	'10	'11	'04	2'48
'09	...	'10	...	'04	'c6	'15	...	'35	...	...	'17	...	'57	...	'10	3'55
'16	'24	...	'09	...	...	...	...	'19	...	...	...	...	...	...	...	2'92
'06	...	...	...	...	...	...	...	'02	...	...	...	...	...	...	...	1'28
'43	...	'14	'23	'25	...	'10	'30	'07	...	...	...	...	'12	...	...	3'33
...	'40	...	'22	...	...	...	...	...	'25	...	...	...	'06	...	...	2'33
...	'08	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0'08
...	'16	...	...	...	...	'16	...	...	...	...	'46	...	...	'08	'02	1'71
'29	'51	'02	...	'21	'01	'08	...	...	...	'03	...	'01	...	...	...	3'47
'28	...	...	...	...	'23	...	'08	'19	'12	...	...	'07	'09	'10	'19	2'08
'28	'15	'19	'23	'59	'09	'06	1'10	'35	...	'14	'46	'04	'10	'13	'14	4'95
...	'04	...	...	...	...	...	...	...	...	...	...	...	'06	'10	'26	0'79
...	...	'01	'02	...	...	...	...	...	...	...	...	...	...	'01	'01	0'27
'10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'28	1'64
'04	'21	'06	'28	'02	...	...	...	'02	...	...	...	...	'03	...	...	1'19
...	...	...	...	...	...	...	'08	'22	...	'10	...	...	'10	'05	...	1'56
...	...	'34	'33	...	'10	...	'06	'30	...	'32	...	'20	...	...	...	2'21
...	...	...	...	...	...	...	...	'25	...	...	...	...	...	'12	...	0'41
...	...	...	...	...	...	...	'07	'20	...	...	'05	'04	'05	...	...	1'92
...	'01	...	...	...	...	...	'01	'01	...	...	'26	...	...	...	...	0'58
'03	...	'04	...	...	...	...	...	...	...	...	'01	'08	'17	...	'33	0'50
...	'13	'23	'12	'04	...	...	...	...	...	...	'11	'33	...	...	'29	1'98
'05	...	'10	'05	'12	'01	'24	'11	...	...	...	...	...	...	...	...	0'70
...	'20	...	...	...	...	...	...	'01	...	...	...	...	'08	'20	...	1'54
'68	'05	'02	...	...	...	...	...	...	...	'01	'20	'23	...	...	...	2'42
...	'20	'19	...	'05	'01	...	...	'02	...	...	...	...	...	...	...	2'10
'28	'01	'05	'12	...	...	...	...	'06	...	...	...	...	...	...	'03	1'30
...	...	...	...	'05	'10	'35	...	...	...	...	...	'06	...	...	...	0'59
'09	'07	...	...	...	...	'05	...	...	...	'02	'40	...	'01	...	...	1'72
'07	'03	...	...	'03	'01	'02	'04	...	'13	...	'01	...	...	'08	'08	0'51
'02	'02	'08	...	'42	'12	...	'02	...	'12	'27	'15	'27	'02	...	'10	1'08
...	...	...	...	...	...	...	...	...	'13	...	...	...	...	'08	...	1'23
...	'01	'02	...	...	...	...	...	...	...	...	...	...	...	'08	...	1'32
...	'03	'02	'11	'10	...	...	...	...	...	...	...	...	...	...	...	0'36
...	...	'26	'25	...	'06	'05	'14	...	'35	'18	...	'02	...	'02	'02	1'67
...	...	...	...	...	'15	...	'15	'07	'26	'26	'10	'14	'09	'12	'02	1'89
'04	'08	...	...	...	'07	...	...	...	...	...	'28	...	...	'10	'20	2'09
'09	...	...	...	...	...	...	...	...	...	...	...	...	...	...	'03	1'25
...	'13	'09	...	...	'02	...	'05	...	...	...	'01	...	'25	'02	...	1'62
...	...	...	...	...	'06	...	...	...	...	...	...	...	...	...	'07	1'08
...	'01	'12	...	'06	'04	...	...	...	...	...	...	...	...	...	'09	0'50
...	...	...	...	...	...	...	...	...	...	'02	...	'04	'31	'23	...	0'87
...	...	'02	...	...	...	'03	'01	...	...	'01	'08	'02	'04	...	...	1'85
...	...	...	'06	...	'18	'01	...	...	...	...	...	...	...	...	...	1'97
'10	'02	'29	...	...	'43	'21	'10	'51	...	'32	'35	'12	'33	'55	...	5'45
'59	...	'15	'09	...	'77	...	...	...	...	...	'01	...	...	'20	...	2'77

The series is mainly that of the Royal Observatory, Greenwich, which began on January 1, 1815, my investigations closing with the end of the year 1869. During this period the fall of rain has been registered at Greenwich daily, from the year 1815 to 1830, and from 1836 to the present time; from 1830 to the end of 1835, the falls were not registered daily, but only at two or three or more days interval, and for the daily falls in this period I have had recourse to a journal in my possession, taken apparently with great care, at High Wycombe, near Reading.

By taking the sums of the numbers in every column of the

TABLE XIII. Showing the Sums of every Fall of Rain on every

Days of the Month.	January.	February.	March.	April.	May.	June.
	in.	in.	in.	in.	in.	in.
1.	1'92	3'54	2'63	3'11	2'14	3'16
2.	2'91	3'12	3'60	2'49	2'92	4'10
3.	2'71	2'34	3'73	2'02	4'41	4'26
4.	2'11	2'91	3'79	1'87	3'57	4'06
5.	3'89	2'55	3'06	2'82	3'39	3'85
6.	3'07	1'83	2'12	1'34	2'35	2'84
7.	2'23	4'80	3'42	3'59	3'72	3'56
8.	2'15	5'28	3'05	3'15	5'36	2'16
9.	2'68	2'36	5'43	4'97	6'13	4'04
10.	2'78	1'87	1'37	2'36	2'71	3'37
11.	5'48	3'11	2'02	1'75	3'85	3'57
12.	2'68	2'99	2'83	4'00	2'92	4'94
13.	5'19	2'77	2'86	3'73	6'14	3'60
14.	4'31	4'47	5'38	2'53	2'66	5'00
15.	3'22	1'62	2'77	3'39	3'56	4'22
16.	3'58	2'01	1'80	3'17	4'90	1'51
17.	2'81	2'11	3'99	2'84	2'32	4'14
18.	3'39	1'35	1'51	2'01	3'32	2'62
19.	2'29	3'10	1'88	2'49	3'15	4'30
20.	4'17	3'67	1'90	4'14	5'27	3'05
21.	2'81	2'75	2'67	2'07	3'17	4'56
22.	3'70	3'14	2'06	4'08	3'26	2'29
23.	2'58	3'26	2'96	4'82	3'79	3'20
24.	2'35	3'19	1'45	4'83	3'00	4'24
25.	2'36	3'30	2'65	4'11	3'76	3'52
26.	3'92	4'87	2'15	2'29	3'44	3'26
27.	3'75	3'25	1'67	3'59	3'90	3'21
28.	2'84	3'26	3'07	1'67	5'20	3'20
29.	3'07	(1'39)	2'37	3'03	5'54	1'75
30.	3'88	...	2'10	2'31	2'63	3'15
31.	4'28	...	3'00	...	3'90	...
Sums ...	99'11	86'21	85'29	90'57	116'38	104'73
Means ..	3'20	3'03	2'75	3'02	3'75	3'49

The first step was collecting in every year, in one sheet, the daily falls of rain in each year, arranged under every month; the next step was collecting into 366 columns (corresponding to the 365 days in the year, and the extra day in leap year) the rain which had fallen on every day of these fifty-five years, so that all the rain which has fallen on the first day of January was ranged in one column, and so on for every day of the year, and in this way the preceding Tables (I. to XII.) were formed.

preceding Tables the next Table was formed.

Day of the Year, in Fifty-five Years (1815 to 1869 inclusive).

July.	August.	September.	October.	November.	December.	Days of the Month.
in.	in.	in.	in.	in.	in.	
4'38	3'78	4'10	6'35	3'85	2'93	1.
4'30	3'63	3'14	3'82	4'13	4'31	2.
2'98	4'97	2'80	4'50	3'03	3'39	3.
3'21	4'67	4'18	5'83	2'79	3'56	4.
4'78	3'77	3'65	4'06	3'00	4'87	5.
2'82	5'16	4'06	5'34	4'10	5'38	6.
4'99	4'27	2'87	7'03	3'42	2'89	7.
3'69	5'25	5'73	3'74	4'10	5'94	8.
2'49	1'84	2'91	3'83	2'49	2'41	9.
3'65	4'33	5'40	2'94	4'34	1'90	10.
2'70	2'85	3'29	5'93	3'79	2'33	11.
4'62	3'22	3'47	3'58	4'77	2'89	12.
3'31	2'98	2'44	1'62	4'95	2'61	13.
4'91	8'75	4'42	2'35	5'27	1'99	14.
5'79	4'81	2'50	5'87	4'28	4'09	15.
6'16	3'65	3'34	2'67	4'90	4'82	16.
2'81	5'76	5'94	3'56	3'15	3'83	17.
5'68	2'58	7'38	5'86	3'85	4'52	18.
5'47	3'32	2'67	5'24	3'19	2'59	19.
5'50	3'33	3'47	4'50	3'81	2'79	20.
5'37	3'08	4'09	3'32	4'11	3'03	21.
2'95	1'99	5'38	7'79	5'26	2'03	22.
4'61	8'29	4'79	5'06	2'81	3'28	23.
6'88	4'28	5'04	4'88	6'06	3'40	24.
5'47	2'40	3'99	7'66	2'60	2'21	25.
9'28	2'68	7'40	4'38	4'78	2'35	26.
5'01	3'01	6'68	5'88	5'16	3'95	27.
5'10	3'19	6'07	4'12	5'64	1'82	28.
3'94	5'68	4'56	5'89	4'90	3'48	29.
2'80	2'24	4'32	6'23	5'14	3'11	30.
4'49	3'73	...	6'06	...	2'51	31.
140'14	123'49	130'08	149'89	123'67	101'21	Sums.
4'52	3'98	4'33	4'83	4'12	3'27	Means.

The observations at the Observatory, from the year 1815 to the year 1847, are those of the gauge placed on the roof of the Library, at the height of 22 feet above the ground, and all results by this gauge need multiplying by 1·3, or being increased by one-third of the fall, to reduce them to falls of rain on the ground.

From the year 1847 to the year 1861, the observations are by Crossley's gauge, and need multiplying by 1·125, or the falls increased by one-eighth part, to reduce them to falls on the ground.

From the year 1861, the readings are of the simple gauge placed with its receiving surface 5 inches above the ground.

These numbers, in every period of the year, vary very much, even from day to day; the least and greatest in every month are as follow:—

		in.		in.		
In January the sums vary from		1·9	on the	1st to	5·5	on the 11th
February	"	1·4	"	18th	5·3	" 8th
March	"	1·4	"	10th	5·4	" 9th
April	"	1·3	"	6th	5·0	" 9th
May	"	2·1	"	1st	6·1	" 13th
June	"	1·5	"	16th	5·0	" 14th
July	"	2·5	"	9th	9·3	" 26th
August	"	1·8	"	9th	8·8	" 14th
September	"	2·4	"	13th	7·4	" 26th
October	"	1·6	"	13th	7·8	" 22nd
November	"	2·5	"	9th	6·1	" 24th
December	"	1·8	"	28th	5·9	" 8th

By taking the differences between these extremes in each month, we find that the smallest difference is in June, viz. 3·5 in., and the largest in August, viz. 7·0 in., and that there is a marked difference in the amounts in the months from July to October, compared with those in the other months of the year; the mean difference of those in the former period being 6·2 in. nearly, and of those in the latter 3·8 in.

By comparing the consecutive numbers in Table XIII. together, very large differences are found; the largest of these in each month are as follow:—

In January ...between the 11th and 12th days, the difference is							in.
February	”	6th	”	7th	”	”	3·0
March	”	9th	”	10th	”	”	4·1
April	”	9th	”	10th	”	”	2·6
May	”	13th	”	14th	”	”	3·5
June	”	15th	”	16th	”	”	2·7
July	”	26th	”	27th	”	”	4·3
August	”	22nd	”	23rd	”	”	6·3
September	”	18th	”	19th	”	”	4·7
October	”	21st	”	22nd	”	”	4·5
November	”	24th	”	25th	”	”	3·5
December	”	8th	”	9th	”	”	3·5

Thus, in fifty-five years, the variations of the causes of rainfall, independently of the relative positions of the earth and sun, are not balanced or obliterated. By comparing the amounts of the falls at different periods of the year, it is at once seen that the heaviest take place in the months of June to October, and the lightest in the early months of the year.

The day in the year distinguished by the smallest fall is April 6, the sum being 1·34 in.; the next in order are February 18 and March 10: the day distinguished by the heaviest fall of the year is July 26, the sum of the falls on this day is 9·28 in.; the next in order is August 14, with 8·75 in.

By taking the sums of the numbers in Table XIII. in five-day periods Table XIV. (p. 116) was formed.

On looking over this Table, we still find considerable differences in every month of the year, and that the sum of five-day periods varies.

In January, from						in.	in.					
February	"	10·2 ...	15th	"	19th	"	17·3 ...	25th	"	March 1st		
March	"	11·3 ...	22nd	"	26th	"	16·3 ...	2nd	"	6th		
April	"	12·3 ...	1st	"	5th	"	19·9 ...	21st	"	25th		
May	"	16·4 ...	1st	"	5th	"	20·7 ...	26th	"	30th		
June	"	14·9 ...	25th	"	29th	"	20·5 ...	10th	"	14th		
July	"	18·0	June 30	"	4th	"	28·8 ...	25th	"	29th		
August	"	15·2 ...	9th	"	13th	"	25·6 ...	14th	"	18th		
September	"	17·6 ...	3rd	"	7th	"	27·9 ...	23rd	"	27th		
October	"	16·1 ...	13th	"	17th	"	27·9 ...	23rd	"	27th		
November	"	17·1 ...	2nd	"	6th	"	24·2 ...	12th	"	16th		
December	"	13·3 ...	22nd	"	26th	"	21·5 ...	2nd	"	6th		

The sums of the falls of rain in five-day periods therefore exhibit very considerable differences in every month; the smallest is in May, viz. 4·3 in., and the largest is in October, 11·8 in.; they are also large in July, August, and September, and the mean difference of the four months, July to October, is 10·8 in., and of the remaining eight months is 6·6 in. only.

The five-day period distinguished by the least rain in the year is from February 15 to 19, and that by the greatest is July 25 to 29; the difference between the two amounts is 18·6 in.

TABLE XIV. Showing the Sum of Rainfall in Five-day Periods.

Periods.	Amounts.	Periods.	Amounts.
	in.		in.
January 1-5	13·54	July 5-9	18·77
6-10	12·91	10-14	19·19
11-15	20·88	15-19	25·91
16-20	16·24	20-24	25·31
21-25	13·80	25-29	28·80
26-30	17·46	July 30-August 3 ...	19·67
January 31-February 4	16·19	August 4-8	23·12
February 5-9	16·82	9-13	15·22
10-14	15·21	14-18	25·55
15-19	10·19	19-23	20·01
20-24	16·01	24-28	15·56
February 25-March 1 ...	17·31	August 29-September 2	18·89
March 2-6	16·30	September 3-7	17·56
7-11	15·29	8-12	20·80
12-16	15·64	13-17	18·64
17-21	11·95	18-22	22·99
22-26	11·27	23-27	27·90
27-31	12·21	September 28-October 2...	25·12
April 1-5	12·31	October 3-7	26·76
6-10	15·41	8-12	20·02
11-15	15·40	13-17	16·07
16-20	14·65	18-22	26·71
21-25	19·91	23-27	27·36
26-30	12·89	October 28-November 1	26·15
May 1-5	16·43	November 2-6	17·05
6-10	20·27	7-11	18·14
11-15	19·13	12-16	24·17
16-20	18·96	17-21	18·11
21-25	16·98	22-26	21·51
26-30	20·71	November 27-December 1	23·77
May 31-June 4	19·48	December 2-6	21·51
June 5-9	16·45	7-11	15·47
10-14	20·48	12-16	16·40
15-19	16·79	17-21	16·76
20-24	17·34	22-26	13·27
25-29	14·94	27-31	14·87
June 30-July 4	18·02		

By taking the numbers in Table XIII. in successive ten-day groups the next Table was formed :—

TABLE XV. Showing the Sum of Rainfall in Ten-day Periods.

	in.		in.
January 1-10	26'45	June 30-July 9	36'79
11-20	37'12	July 10-19	45'10
21-30	31'26	20-29	54'11
January 31-February 9	33'01	July 30-August 8 ...	42'79
February 10-19	25'40	August 9-18	40'77
February 20-March 1.....	33'32	19-28	35'57
March 2-11	31'59	August 29-September 7	36'45
12-21	27'59	September 8-17	39'44
22-31	23'48	18-27	50'89
April 1-10	27'72	September 28-October 7	51'88
11-20	30'05	October 8-17	36'09
21-30	32'80	18-27	54'57
May 1-10	36'70	October 28-November 6	43'20
11-20	38'09	November 7-16	42'31
21-30	37'69	17-26	39'62
May 31-June 9	35'93	November 27-December 6	45'28
June 10-19	37'27	December 7-16	31'87
20-29	32'28	17-26	30'03

The differences between these numbers are at times great ; in January the sum in the second decade is 10'7 in. larger than in the first ten days ; but this is the largest difference between the sums of consecutive ten-day periods till between the period ending July 29 and that ending August 8, which is 11'3 in. ; the largest difference in the year is between the periods ending October 17 and October 27, which is 18'48 in.

The period of least changes, generally, between consecutive ten-day periods extends from the 60th day to the 190th, or from February 19 to July 9 ; and within this period the driest ten-day period takes place, viz. from March 22 to March 31 ; the next in order is February 10th to the 19th, and then January 1st to the 10th.

The wettest period of ten consecutive days in the year is from October 18th to the 27th, and is more than double in amount of the fall from January 1st to the 10th. The other periods of large falls are July 20th to the 29th, September 18th to the 27th, and September 28th to October 7th ; it is remarkable that the period October 8th to the 17th, between these very heavy ten-day falls, is so small in amount of rain.

By taking the sums in fifteen-day periods the next Table was formed.

TABLE XVI. Showing the Sum of Rainfall in Fifteen-day Periods.

	in.		in.
January 1-15	47'33	June 30-July 14	55'98
16-30	47'50	July 15-29	80'02
January 31-February 14	48'22	July 30-August 13 ...	58'01
February 15-March 1	43'31	August 14-28	61'12
March 2-16	47'23	August 29-September 12	57'25
17-31	35'43	September 13-27	69'53
April 1-15	43'12	September 28-October 12 ...	71'90
16-30	47'45	13-27	70'64
May 1-15	55'83	October 28-November 11	61'34
16-30	56'65	12-16	63'79
May 31-June 14	56'41	November 27-December 11	60'75
June 15-29	49'07	December 12-26	46'43

The differences between these numbers to March 16th are small; they are generally large from this date to the end of the year; the largest are in July.

The ten-day period of least rain is from March 17 to March 31, and the next in order is from April 1 to April 15.

The period of most rain is July 15 to July 29, and the next in order is September 28 to October 12, and October 13 to 27.

By taking the sums of rain in successive periods of thirty days, we find that the sum—

From January ... 1st to January ... 30th was	in.	94'83
„ 31st to March..... 1st „	91'73	
March..... 2nd „ „ 31st „	82'66	
April 1st „ April..... 30th „	90'57	
May 1st „ May 30th „	112'48	
„ 31st „ June..... 29th „	105'48	
June 30th „ July 29th „	136'00	
July 30th „ August... 28th „	119'13	
August... 29th „ September 27th „	126'78	
September 28th „ October 27th „	142'54	
October ... 28th „ November 26th „	125'13	
November 27th „ December 26th „	107'18	

From this we see that the period of thirty consecutive days of least fall of rain is from March 2 to March 31, and of the greatest from September 28 to October 27.

By taking the sums of the amounts of rain which fell on every day, in periods of sixty days, we find that the sum :—

From January 1st to March ... 1st	was	186.56	in.
March ... 2nd „ April..... 30th	„	173.23	
May..... 1st „ June 29th	„	217.96	
June ... 30th „ August ... 28th	„	255.13	
August 29th „ October... 27th	„	269.32	
October 28th „ December 26th	„	232.31	

The period of least fall of sixty days' duration was from March 2 to April 30, and of the greatest from August 29 to October 27.

Again, by taking periods of successive ninety days, we see that the sum—

From January 1st to March ... 31st	was	269.22	in.
April ... 1st „ June 29th	„	308.53	
June ... 30th „ September 27th	„	381.91	
September 28th „ December 26th	„	374.85	

But the sum of the falls in the ninety days from January 31 to April 30 was 264.96, being smaller than in the period from January 1 to March 31.

Taking successive periods of 120 days, the sums of the falls are—

From January 1st to April..... 30th	was	359.79	in.
May 1st „ August... 28th	„	473.09	
August ... 29th „ December 26th	„	501.63	

But these sums do not represent the 120 days of greatest rain, the sum of the falls from July 30 to November 26 being 513.58 in.; and that from June 30 to October 27 is 524.45 in., which represents the greatest in the year.

Collecting together the several periods of least rain, we find that—

The 5-day period of least rain was from Feb. 15th to Feb. 19th			
10	„	Mar. 22nd	„ Mar. 31st
15	„	„ 17th	„ „ 31st
30	„	„ 2nd	„ „ 31st
60	„	„ 2nd	„ April 30th
90	„	Jan. 31st	„ „ 30th
120	„	„ 1st	„ „ 30th

Thus all the periods of least falls of rain take place within the first 120 days of the year.

In like manner, collecting the periods of heaviest falls, we find that—

The 5-day period of heaviest rain was from July 25th to July 29th

10	"	"	Oct. 18th	"	Oct. 27th
15	"	"	July 15th	"	July 29th
30	"	"	Sept. 28th	"	Oct. 27th
60	"	"	Aug. 29th	"	" 27th
90	"	"	Sept. 8th	"	Dec. 6th
120	"	"	June 30th	"	" 27th

Thus all the periods of heaviest rains take place in the period from June 30 to December.

By taking the means of the numbers in Table XIII. in each month, we find that the average sums of the falls of rain in fifty-five years was—

In January	3.20	inches	per	day,
February	3.03	"	"	"
March	2.75	"	"	"
April	3.02	"	"	"
May	3.75	"	"	"
June	3.49	"	"	"
July	4.52	"	"	"
August	3.98	"	"	"
September.....	4.33	"	"	"
October..	4.83	"	"	"
November.....	4.12	"	"	"
December.....	3.27	"	"	"

And by dividing these numbers by 55, we find the average fall per day in each month as follows:—

In January	.058	inch	per	day,
February	.055	"	"	"
March	.050	"	"	"
April.....	.055	"	"	"
May	.068	"	"	"
June.....	.064	"	"	"
July	.082	"	"	"
August.....	.072	"	"	"
September	.079	"	"	"
October	.088	"	"	"
November	.075	"	"	"
December.....	.059	"	"	"

The average daily rainfall in the first 120 days, being those of

least rain, is 0·0543 in. ; and the period June 30 to October 27, being that of the greatest rain, is 0·085 in.

By taking the sums of the falls of rain in the several periods of least and greatest falls, and dividing the sums by the numbers as follows, in the

		in.		in.
5 days of least falls the sum was		10·19	or, per day,	2·04
10	" "	23·48	" "	2·35
15	" "	35·43	" "	2·36
30	" "	82·66	" "	2·75
60	" "	173·23	" "	2·89
90	" "	264·96	" "	2·94
120	" "	359·79	" "	3·00

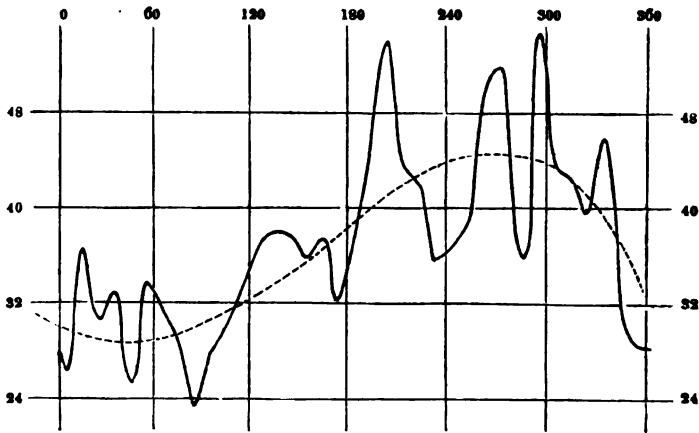
and of

		in.		in.
5 days of greatest falls the sum was		28·80	or, per day,	5·76
10	" "	54·57	" "	5·46
15	" "	80·02	" "	5·33
30	" "	142·54	" "	4·75
60	" "	269·82	" "	4·49
90	" "	381·91	" "	4·24
120	" "	524·45	" "	4·37

If we divide the numbers in the last column by 55 we find that the average fall per day in the

		in.		in.
5 days of least rain was	·087,	and of the greatest was	·105	
10	" "	·043	" "	·099
15	" "	·043	" "	·097
30	" "	·050	" "	·086
60	" "	·053	" "	·082
90	" "	·053	" "	·077
120	" "	·055	" "	·079

Laying down the results as found by the ten-day period, the following diagram shows the general run of the rainfall for the year.



The minimum, as observed, appears between the 80th and 90th days of the year, and the maximum between the 290th and 300th days; the next in order is that between the 200th and 210th days; but this latter period includes and is caused by the very great fall of 3·67 in., which took place on the 26th of July, in the year 1867.

By drawing a line through the curve, giving equal weight to every point, the dotted curved line is drawn: if we consider this to represent the annual march of the fall of rain, it seems that the minimum is from the 30th to the 60th days; that it increases gradually to the maximum between the 260th and 280th days, then to decline slowly to the 320th, and rapidly afterwards till toward the end of the year, when a secondary minimum takes place, and increases to a secondary maximum at about the middle of January. If we read the numbers from this curve, and divide them first by 10 and then by 55, we shall have the mean daily fall in each period, and it is as follows:—at about January 1 it is 0·056 in.; January 15, 0·058 in.; decreasing to 0·051 in. from the 60th to the 80th days of the year; increasing gradually to 0·083 in. from the 260th to the 280th day, and decreasing quickly to 0·056 in. by the end of the year.

Of the frequency of rainfall at the different times of the year I hope to speak in a future number.



ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line	0	0	6	Title, half-sheet and less	1	10	0
Half a page	0	17	0	" whole sheet	2	10	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

Session 1869-70.

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1869, November	17	1870, March	16
1870, January	19	" April	20
February	10	" June (JUNIAL)	18

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Houses of Observation, for different Ranges of Daily Temperatures, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS,

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. BELVILLE'S Books.—*otherwise*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1870, APRIL 20.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
XIII. On the Rainfall in Natal, South Africa.—R. J. Mann, M.D., F.R.A.S., F.M.S., &c., Superintendent of Education in the Colony.....	123
XIV. On some of the Laws which appear to regulate the Temperature of Summer Months and Seasons.—George D. Brumham, F.M.S.	129
XV. Meteorology of Clifton (Bristol) for the Quarter ending March 31, 1870.—A. North, F.R.G.S., F.M.S.....	136
XVI. Daily Rainfall at Cobham and Chiswick, from 1826 to 1865.— George Dines, F.M.S.	136

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, May.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.]

1870, APRIL 20.

[No. 49.]

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Armitstead, Rev. T. B., B.A. Oxon., *Hutton House, Burton, West-
moreland* ;

Kains-Jackson, Henry, 60 *Mark Lane*, E.C. ;

Marriott, William, 1 *Prior Street, Greenwich*, S.E. ;

Simpson, James, C.E., 29 *Great George Street, Westminster*, S.W. ;

Wright, Thomas, 20 *The Vale, Blackheath*, S.E. ;

were balloted for and duly elected Fellows of the Society.

The names of Two Candidates for admission into the Society
were read. Professor Denza, Director of the Observatory, Mon-
calieri, was also proposed as an Honorary Member.

XIII. *On the Rainfall in Natal, South Africa.* By R. J. MANN,
M.D., F.R.A.S., F.M.S., &c., Superintendent of Education in
the Colony.

THE rainfall in Natal, South Africa, was made the subject of a
communication to the Society in April 1868*. Upon that occa-

* See no. 37, vol. iv. of the Proceedings, pp. 139-154.

sion the monthly fall for the city of Maritzburg (2095 feet above the sea) was given for a period of eight years—namely, from 1858 to 1865.

The object of the paper now submitted is to extend that record to a period of ten years, ending in December 1867.

The rainfall for the year—

	inches.
1866	was 30·266
1867	„ 31·490

The mean yearly rainfall for the ten-year period

1858 to 1867..... was 30·354

The total fall for the period of ten years was 303·546 inches ; that is, 25½ feet.

The mean fall for each month of the year now comes out from this ten-year period.

	Mean Rainfall.
	inches.
January	3·97
February.....	4·45
March	3·46
April	1·58
May.....	0·75
June	0·23
July.....	0·25
August	1·01
September	1·41
October	3·29
November	4·91
December	4·87

Of the average yearly fall of 30 inches, nearly 25 inches thus fall during the six summer months of the year; just 3 inches fall during the two intermediate, or transition, months, April and September; and a little more than 2 inches fall during the four dry winter months. The Natal seasons thus obviously divide themselves into—

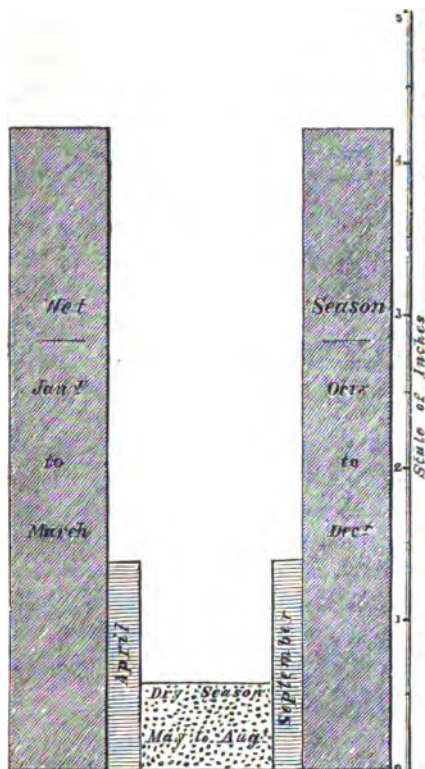
1. A wet period of six months, extending from October to March, in which the average monthly fall is 4½ inches.

2. A dry period of four months, from May to August, in which the average monthly fall is a trifle over half an inch.

3. An intermediate, or transition, period of two months, April and September, in which the average monthly fall is 1½ inch.

If the intermediate periods were taken to consist of the four months April, May, August and September, and the dry period of only the two midwinter months, June and July, then the monthly mean for the intermediate period would be $1\frac{1}{2}$ inch, and the monthly mean for the dry period $\frac{1}{2}$ inch nearly.

This seasonal distribution of the rainfall of Natal may be most readily expressed to the eye by the following diagram.



The largest monthly fall in the ten-year period continues to be 8.95 inches, which happened in the month of November.

The greatest fall for each month of the year for the ten-year period is still the series given at p. 146 of vol. iv., with the one exception, that the numbers for April must be changed to 3.14 inches.

It will be observed that in this ten-year period the era of least fall was 1861, and the era of greatest fall 1864. The years 1858, 1859,

1860–1862, 1865, 1866, 1867 were all approximately years of average rainfall. It will be observed that the difference between the greatest and least yearly fall was only $12\frac{1}{4}$ inches; the greatest and the least yearly falls being approximately in the ratio of 3 to 2.

During this ten-year period there was one occasion on which rain did not fall during 107 days. On four other occasions there were periods of 68, 58, 56, and 51 rainless days. Twice there were 42 rainless days together; six times there were between 30 and 40 rainless days, and eight times between 20 and 30 rainless days together. These, however, were the only occasions on which 20 days passed without rainfall.

To the list of heaviest daily rainfalls given at p. 149, vol. iv., four cases have to be added, on which the fall within twenty-four hours exceeded $1\frac{1}{2}$ inch to complete the ten-year period; these were—

	inches.
January 27, 1866	1·825
March 1, 1866	1·820
February 12, 1867	1·540
April 24, 1867	2·080

There were therefore only five occasions in the ten-year period on which the daily fall exceeded 2 inches; and $2\frac{1}{2}$ inches continues to be, for that period, the heaviest daily fall.

The remarkable fact that the entire rainfall is heavier near the level of the sea than at a height of 2095 feet has been already alluded to. The following series gives, in illustration of this statement, the exact monthly rainfall for the City of Maritzburg, 2095 feet above the sea-level, and for the Port of Durban, near the sea-level, for a period of two years.

Rainfall at Maritzburg and Durban in the several Months of the
Years 1866 and 1867.

1866.	Maritzburg.	Durban.
	inches.	inches.
January	4'965	1'010
February	3'565	2'670
March	4'448	20'190
April	1'148	1'200
May	0'000	2'410
June	0'250	0'000
July	0'410	1'210
August	0'590	2'130
September	1'850	3'980
October	1'100	4'370
November	5'790	5'760
December	5'150	3'610
Total yearly fall...	30'266	48'540

1867.	Maritzburg.	Durban.
	inches.	inches.
January	3'400	1'110
February	5'660	5'410
March	3'860	3'660
April	3'140	6'890
May	0'000	0'070
June	0'000	1'260
July	0'000	0'160
August	0'370	0'430
September	2'040	2'210
October	3'080	4'240
November	6'690	5'490
December	3'250	1'520
Total yearly fall...	31'490	33'080

The irregularity expressed in these numbers—very strikingly brought out in the total yearly falls for the two years, in which it will be seen that the ratio is approximately

2 to 3 in the one case, and
63 to 66 in the other case,

—is due to the fact, which has been already dwelt upon, that the rainfall in Natal is attributable to two altogether distinct classes of cause, namely, the drift of the prevalent moist ocean-breeze up the landslope of the African continent, and the periodic manufacture of thunderstorms. The former cause gives more rain on the coast

than on the hills 2000 feet high, at periods when the sea-wind comes in to the land with the force of a violent gale. The thunderstorms are more evenly distributed, and, upon the whole, go some distance to compensate the greater fall of the sea-rains on the immediate coast, because they are somewhat more frequent and more violent at the higher elevation among the hills. The exact proportion of coast- and hill-rainfalls for any given period would, therefore be largely dependent upon the preponderance of the one or other of these water-depositing influences during that interval. Thus it is quite possible at once to say, upon a mere glance at the series of figures just recorded, that sea-gales were more violent on the Natal coast in the year 1866 than in the year 1867. A long series of relative observations will, however, be necessary to disentangle these two influences, and to get the expression of order and law for each. In the meantime the question of the influence of elevation in determining the amount of aqueous deposit during the normal sea-rains, at this station, is a very interesting one, concerning which it is hoped there will be some facts to record ere long. The observations to settle the law of this influence will, however, have to be carefully restricted to the occurrence of steady sea-rains, in order to eliminate the disturbing action of the frequent thunderstorms.

The maximum rainfall in the neighbouring island of the Mauritius, where the thunderstorm disturbance is very much less strongly marked, occurs at a height of nearly 1000 feet. On the coast of Natal the maximum rainfall will certainly be found at a very much lower elevation than this. The three special instances already recorded in the Journal of the Society, in which the rainfall on the coast and at an elevation of 2095 feet were—

	inches.	inches.	inches.
Coast	8·97	27·00	16·54
2095 feet elevation ...	1·23	11·00	10·81*

will be borne in mind.

The rainfall at Maritzburg, the capital of Natal, situated 2095 feet above the sea, for each month of the ten-year period running from 1858 to 1867, is given in the following series:—

* See pp. 153 and 233, vol. iv.

Months.	1858.	1859.	1860.	1861.	1862.
	in.	in.	in.	in.	in.
January	2'82	3'92	2'30	2'17	5'31
February	2'31	3'05	4'19	4'45	3'24
March	3'95	2'89	0'83	2'43	3'74
April	1'48	0'75	1'72	2'02	1'98
May	0'00	0'92	0'39	0'66	1'40
June	0'09	0'55	0'06	0'00	0'00
July	0'15	0'74	0'04	0'04	0'03
August	3'44	1'20	1'34	0'08	1'29
September	0'08	1'69	3'11	0'21	0'64
October	3'26	4'36	3'54	3'12	2'14
November	4'15	4'64	8'95	2'49	4'05
December	5'68	3'63	4'13	4'67	6'14

Months.	1863.	1864.	1865.	1866.	1867.
	in.	in.	in.	in.	in.
January	1'80	6'63	6'41	4'97	3'40
February	5'53	7'59	4'94	3'57	5'66
March	2'91	5'04	4'57	4'45	3'86
April	1'70	0'19	1'74	1'15	3'14
May	2'94	0'89	0'39	0'00	0'00
June	0'08	0'07	1'28	0'25	0'00
July	0'74	0'00	0'10	0'41	0'00
August	0'20	0'34	1'26	0'59	0'37
September	1'75	0'67	2'44	1'85	2'04
October	7'21	4'20	0'93	1'10	3'08
November	3'75	5'46	3'18	5'79	6'69
December	6'00	6'23	3'84	5'15	3'25

XIV. *On some of the Laws which appear to regulate the Temperature of Summer Months and Seasons.* By GEORGE D. BRUMHAM, F.M.S.

IN a paper read before the Society in February 1868, I stated that the development of predictive meteorology appeared mainly to depend on the due application of principles of uniformity and regularity. I then gave a number of laws in connexion with those principles. The existence of those laws appeared to be established from a discussion of Mr. Glaisher's valuable monthly mean-temperature tables. This was, so far, satisfactory. In order, however, to ascertain whether the laws were susceptible of any thing like universal application, it was necessary to examine tables of the monthly mean-temperatures of foreign stations.

For this purpose, the tables in Lorin Blodget's 'Climatology of the United States' seemed suitable. I therefore commenced examining them, and have now much pleasure in laying the results of my investigations before the Society. Charleston and a few other places appear to furnish some exceptions to the law. The Charleston series puzzled me very much for some time; but, on reading the remarks of the author relative to this station (at the 45th and 46th lines of page 67), I saw that the fault was in the table of observations and not in the law. The author says:—"At Charleston the observations by Dr. Lining were computed from the extremes daily, and the ten years by Dr. Chalmers were so observed; but in those there are certainly errors of computation." On the other hand, the New-York series, which is the most correct, is that to which the law of uniformity applies with almost mathematical accuracy. At the 32nd line of page 67, Lorin Blodget makes the following remarks with regard to the New-York table:—"The series is more than usually accurate; it correctly represents the City of New York." At New Orleans and Washington, as well as at New York, the law of uniformity is, apparently, infallible, as the following rule and Table will show:—

When two in succession of the first four months of the year have been so nearly uniform that the range of monthly mean temperature has been only $0^{\circ}5$ or less, the succeeding summer (reckoning from May to September inclusive) has invariably been characterized by unusual heat. Table I. contains *all* the instances relative to this law that occurred at New York, New Orleans, and Washington during the years given by Lorin Blodget. The New-York series of years extends from 1822 to 1854, New Orleans the same, and Washington for a few years between 1819 and 1842. The average referred to in the last column but one of the following Table is not the same at each station; it is the mean summer temperature of the series at each place.

TABLE I.

References to the Notes.	Name of Station.	Year.	Mean Temperature of				Range of Means.	Difference from the averages of May to September.	Maximum Temperature.
			Jan.	Feb.	Mar.	Apr.			
1.	New York ...	1825.	32°7	32°6	.....	.....	0°1	+3°6	104° in July.
2.	" ...	1830.	31°7	31°9	.....	.....	0°2	+2°4	98 "
	" ...	1854.	28°7	28°2	.....	.....	0°5	+0°4	93 "
3.	New Orleans	1825.	53°3	53°3	.....	.....	0°0	+2°2	Not recorded.
4.	"	1841.	55°4	55°6	.....	.....	0°2	+1°8	100 in July.
	"	1852.	.....	.....	67°0	67°3	0°3	+1°1	95 "
	"	1828.	.....	64°7	64°3	.....	0°4	+1°2	93 in June.
5.	Washington	1830.	33°8	33°7	.....	.....	0°1	+1°7	98 in Aug.
6.	"	1828.	.....	47°2	47°5	.....	0°3	+2°4	94 in July and Sept.

- (1) In 1825 New York had the hottest entire summer, the hottest month, viz. July, the mean temperature of which was 81°·3, and the highest maximum temperature (104°) ever recorded there up to 1854.
- (2) In 1830 the next hottest month occurred at New York, viz. July, the mean temperature of which was 78°·7, and the hottest August also occurred this year.
- (3) In 1825 New Orleans had the hottest entire summer, and the hottest May ever recorded there.
- (4) The summer of 1841 was the next hottest, except that of 1830, which was about the same. July 1841 was the hottest month ever recorded at New Orleans up to 1854, and in the same month there occurred the hottest entire day ever known at that place.
- (5) The hottest month of the series (July) occurred this year.
- (6) The hottest June of the series occurred this year.

The following facts, taken in connexion with the foregoing Table, appear to demonstrate the truth of the law of uniformity as regards its application to the climate of the United States:—

1. At New York the nearest approach to complete uniformity in the first four months of the year was in 1825; and the five months' summer of that year was the hottest on record there up to 1854. The mean temperature of July 1825 was *more than 2½° above that of any other month* in the thirty-three years of the series, and it is the *only* year in which the maximum temperature exceeded 100°.

2. At New Orleans there was an instance of complete uniformity at the beginning of the year 1825, the mean temperature of February being exactly the same as that of January; and the following five months' summer was the hottest on record there between the years 1820 and 1855. In that summer the maximum

temperature reached 100° . In 1850 there was an instance of exact uniformity as regards the arithmetical progression of mean temperature at New Orleans; in that year the difference between the mean of March and the mean of April was exactly the same as the difference between the mean of April and the mean of May, viz. $4^{\circ}2$ in each case, and in the following summer the maximum temperature reached 100° .

3. Not only have *all* the summers at New Orleans that were preceded by uniform monthly means, or differences, in the first four or five months of the year been distinguished for extraordinary maximum temperatures, but there is no year in the whole series, except 1840, in which the maximum temperature has reached 100° without this uniformity having prevailed; and even in 1840 the uniformity, as regards the arithmetical progression of mean temperature, wanted only $0^{\circ}2$ to make it complete.

4. The years distinguished by very cold summers appear to have been preceded by very irregular monthly mean temperatures. For instance, in 1837 the mean temperature of January at New York was $26^{\circ}3$, in February it rose $3^{\circ}5$, in March $5^{\circ}1$, and in April $11^{\circ}1$; and the following summer appears to have been the coldest on record there up to 1854. In 1836 there was great irregularity in the monthly mean temperatures at New York. In that year the mean temperature of January was $27^{\circ}8$, in February it fell $6^{\circ}3$, in March it rose $10^{\circ}7$, and in April it rose $12^{\circ}1$; and the following summer was remarkably cold. In 1835 and 1839 there was a similar want of uniformity in the first four months of the year at New York, and in each of those years the mean temperature of the summer was very low.

It appears, as far as I can ascertain, that the climate of Great Britain is the only one which furnishes instances of almost complete uniformity in the mean temperatures of three consecutive months at the beginning of the year. In my former paper I stated that a remarkably narrow range of monthly mean temperature occurred at Greenwich in the first quarter of 1806, 1808, 1825, 1846, 1852, and 1865; and in each of those years the summer was extremely hot. I also stated that these were the only years in which such a striking uniformity occurred in the first quarter of the year. This is true as far as the first quarter of the year is concerned. I have, however, recently discovered that, in the year 1849, the three consecutive months of February, March, and April were similarly uniform; the range of monthly

mean temperature in that period was only $0^{\circ}7$, and the succeeding summer was very hot. The mean temperature of May to September inclusive in 1849 was more than $1^{\circ}2$ above the average of ninety-nine years. From 1771 to the present time (1870) there is no other instance of approximate uniformity in the Greenwich monthly mean temperatures of February, March, and April; but even this single instance makes it appear probable that the law should be applied to the fourth month of the year as well as to the first three.

If we look at the indications of approaching heat afforded by a two-monthly uniformity of mean temperature, we shall see that April is a most important month in connexion with the law of uniformity. The following rules and Tables will show this.

When the mean temperature of February is not less than 38° , the mean of March not less than 41° , and the mean of April is not less than 45° , and the mean temperatures of two of the first four months of the year are considerably within 2° of being uniform, the succeeding three months' or five months' summer is *always* hot or warm. The following are *all* the instances relative to this law that have occurred at the Royal Observatory, Greenwich, between the years 1770 and 1870.

TABLE II.

Year.	Range of Means.	Mean Temperature of				Difference from average of		Maximum Temperature near London or in Suffolk.
		Jan.	Feb.	Mar.	Apr.	June to August.	May to Sept.	
1859.	$0^{\circ}2$	.....	.....	$46^{\circ}4$	$46^{\circ}6$	$+4^{\circ}2$	$+2^{\circ}8$	93° at Greenwich.
1846.	$0^{\circ}2$	$43^{\circ}7$	$43^{\circ}9$	.....	.....	$+4^{\circ}2$	$+3^{\circ}7$	95° at Chiswick.
1775.	$0^{\circ}2$	.....	$41^{\circ}9$	$41^{\circ}7$	.....	$+2^{\circ}0$	$+1^{\circ}8$	85° in Suffolk in April.
1835.	$0^{\circ}2$	.....	$41^{\circ}2$	$41^{\circ}0$	.....	$+2^{\circ}5$	$+1^{\circ}7$	92° at Chiswick.
1863.	$0^{\circ}3$	$41^{\circ}8$	$42^{\circ}1$	.....	.....	$+0^{\circ}2$	$-0^{\circ}5$	88° " "
1842.	$0^{\circ}3$	.....	.....	$44^{\circ}9$	$45^{\circ}2$	$+2^{\circ}7$	$+1^{\circ}6$	93° " "
1794.	$0^{\circ}4$	.....	$44^{\circ}7$	$44^{\circ}3$	.....	$+0^{\circ}6$	$-0^{\circ}5$	87° in Suffolk.
1848.	$0^{\circ}4$	.....	$43^{\circ}4$	$43^{\circ}8$	.....	$-0^{\circ}6$	$+1^{\circ}0$	88° at Chiswick.
1852.	$0^{\circ}5$	.....	$40^{\circ}8$	$41^{\circ}3$	.....	$+1^{\circ}5$	$+0^{\circ}8$	97° " "
1822.	$0^{\circ}6$	.....	.....	$47^{\circ}3$	$46^{\circ}7$	$+2^{\circ}0$	$+1^{\circ}8$	92° at Tottenham.
1868.	$1^{\circ}0$	.....	$43^{\circ}0$	$44^{\circ}0$	.....	$+4^{\circ}2$	$+4^{\circ}3$	$96^{\circ}6$ at Greenwich.
1834.	$1^{\circ}0$	.....	.....	$44^{\circ}0$	$45^{\circ}0$	$+2^{\circ}4$	$+2^{\circ}7$	94° at Chiswick.
1826.	$1^{\circ}0$	.....	$42^{\circ}2$	$43^{\circ}2$	.....	$+3^{\circ}8$	$+1^{\circ}8$	92° at Tottenham.
1801.	$1^{\circ}3$	.....	.....	$44^{\circ}1$	$45^{\circ}4$	$+0^{\circ}3$	$+0^{\circ}9$	85° Suffolk.
1815.	$1^{\circ}6$	.....	.....	$45^{\circ}0$	$46^{\circ}6$	$-0^{\circ}7$	$+1^{\circ}2$	83° " "
1779.	$1^{\circ}7$	.....	$45^{\circ}3$	$47^{\circ}0$	.....	$+2^{\circ}3$	$+2^{\circ}5$	94° " "

When the mean temperature of April is *not less* than 45° , and

the mean temperature of January is considerably within 2° of being the same as the mean of March, the succeeding summer is *always* hot or warm. The following are all the instances of this kind in the last ninety-nine years.

TABLE III.

References to the Notes.	Year.	Range of Means.	Mean Temperature of		Difference from averages of		Maximum Temperature near London or in Suffolk.
			January.	March.	June to August.	April to Sept.	
	1825.	$0^{\circ}1$	$38^{\circ}4$	$38^{\circ}5$	$+1^{\circ}8$	$+2^{\circ}1$	97° at Tottenham.
	1865.	$0^{\circ}3$	$36^{\circ}3$	$36^{\circ}6$	$+1^{\circ}2$	$+3^{\circ}5$	89° at Chiswick.
	1807.	$0^{\circ}3$	$36^{\circ}7$	$37^{\circ}0$	$+1^{\circ}5$	$+0^{\circ}5$	87° at Plaistow.
	1846.	$0^{\circ}4$	$43^{\circ}7$	$43^{\circ}3$	$+4^{\circ}2$	$+3^{\circ}2$	95° at Chiswick.
	1834.	$0^{\circ}4$	$44^{\circ}4$	$44^{\circ}0$	$+2^{\circ}4$	$+2^{\circ}0$	94° "
	1800.	$0^{\circ}6$	$36^{\circ}9$	$37^{\circ}5$	$+0^{\circ}6$	$+1^{\circ}1$	88° in Suffolk.
	1852.	$0^{\circ}7$	$42^{\circ}0$	$41^{\circ}3$	$+1^{\circ}5$	$+0^{\circ}6$	97° at Chiswick.
	1856.	$0^{\circ}7$	$39^{\circ}4$	$38^{\circ}7$	$+1^{\circ}0$	$-0^{\circ}1$	92° "
	1783.	$0^{\circ}8$	$36^{\circ}9$	$37^{\circ}7$	$+1^{\circ}5$	$0^{\circ}0$	90° in Suffolk.
1.	1788.	$1^{\circ}2$	$37^{\circ}4$	$38^{\circ}6$	$-0^{\circ}4$	$+0^{\circ}9$	85° "
	1775.	$1^{\circ}3$	$40^{\circ}4$	$41^{\circ}7$	$+2^{\circ}0$	$+2^{\circ}2$	85° "
2.	1840.	$1^{\circ}4$	$39^{\circ}0$	$37^{\circ}6$	$-0^{\circ}3$	$+0^{\circ}1$	86° "
	1818.	$1^{\circ}6$	$39^{\circ}3$	$40^{\circ}9$	$+4^{\circ}1$	$+2^{\circ}7$	93° at Tottenham.

- (1) Mr. Glaisher says, "The summer of 1788 was in general dry, and there were several periods of *hot* weather in April, May, and June."
- (2) Mr. Whittlecraft says, "In 1840 the season was *unusually warm*: the heat was very great from July 14 to September 22 with very little intermission."

When the mean temperature of March is less than $39^{\circ}9$, the mean temperature of the succeeding summer (reckoning from June to August inclusive) is *always* below Mr. Glaisher's adopted average of fifty years, provided that the mean temperatures of the first three months of the year or of January and March have not been within $1^{\circ}5$ of uniformity. The following are *all* the years since 1770 that have furnished instances relative to this law:—1771, 1772, 1784, 1785, 1786, 1793, 1795, 1796, 1797, 1799, 1812, 1814, 1816, 1823, 1824, 1829, 1833, 1837, 1839, 1845, 1853, 1855, 1867, and 1869. In each of these years the summer was below the average, and, in most cases, it was very cold.

When the mean temperature of April is below $43^{\circ}5$, the mean temperature of the following summer is *always* below the average of fifty years, provided that the mean temperatures of the first three months of the year, or of January and March, have not been

within 1° of uniformity. The following are *all* the years since 1770 that have furnished instances relative to this rule:—1771, 1772, 1784, 1790, 1793, 1799, 1809, 1812, 1816, 1823, 1836, 1837, 1838, 1839, and 1860.

It appears that when the mean temperature of April is below 41° the following summer is cold, although the means of January and March have been nearly the same. Such was the case in 1782.

When the mean temperature of March has been 47°, or above, we have *always* had a hot summer follow. It was so in 1779, 1780, and 1822.

Lastly, when the uniformity has been similar to that which occurred at New Orleans in 1850, the summer has been very hot. In 1857 the difference between the mean temperature of January and the mean temperature of February was exactly the same as the difference between the mean of February and the mean of March, viz. 2°·6; and in that year we had a remarkably hot summer.

It appears from the foregoing statements that, in looking at monthly mean temperatures as signs of future weather, the law of uniformity should be borne in mind; it certainly (to use the words of Howard, when speaking of lunar influence) may very well be placed among the elements of the problem of the weather for a given season. In some years the modifying influence of the law is particularly conspicuous. In 1808, for instance, the months of March and April were abnormally cold, and, judging from this alone, the summer should have been very cold; but as there was a striking uniformity in the monthly mean temperatures of the first quarter of the year, the following summer was abnormally hot. The maximum temperature in July 1808 was 96° at Plaistow, which is nearly the same as the highest temperature registered at Greenwich in the extraordinary summer of 1868. In 1806 the mean temperatures of March and April were very low; but as there was a remarkable uniformity in the means of the first quarter of the year, the summer was hot.

On the other hand, in 1841, March and April were very warm; but as the monthly mean temperatures in the first quarter of that year were very irregular, the summer was very cold.

XV. Meteorology of Clifton (Bristol) for the Quarter ending March 31, 1870. By A. NORTH, F.R.G.S., F.M.S.

Months.	Barometer in Month.				Temperature in Month.			
	Highest Reading.	Lowest Reading.	Range.	Mean reduced to 32° Fahr.	Highest.	Lowest.	Range.	Mean of all Highest.
January ...	in. 30°575	in. 29°276	in. 1°299	in. 29°982	51°8	24°9	26°9	42°8
February ...	30°407	29°356	1°051	29°845	55°4	22°0	33°4	41°2
March ...	30°480	29°485	0°995	30°065	54°0	27°2	26°8	47°4
Mean ...	30°487	29°372	1°115	29°964	55°4 (Max.)	22°0 (Min.)	33°4 (Range)	43°8

	Temp. in Month.			Humidity.		Rain in Month.		
	Mean of all Lowest.	Mean Daily Range.	Mean Temperature.	Least during Month.	Mean for Month.	Greatest Daily fall.	Date.	Number of Days it fell.
January ..	36°2	6°6	39°3	63	87	in. 0°664	8th	14
February ..	33°5	7°7	36°9	49	82	0°503	6th	10
March ...	36°3	11°1	41°3	45	76	0°534	1st	8
Mean ...	35°3	8°5	39°2	45 (Least)	82	0°664 (Max.)	.....	32 (Sum)
								5°005 (Sum)

XVI. Daily Rainfall at Cobham and Chiswick, from 1826 to 1865. By GEORGE DINES, F.M.S.

At the last Meeting of this Society a wish was expressed that I should give a summary of the daily rainfall at Cobham and Chiswick, as supplementary to Mr. Glaisher's paper upon the fall of rain on every day of the year, from 1815–1869.

I have therefore prepared the following Table, which shows the total daily rainfall at each of the two places for every day of the year during a period of forty years, 1826–1865. I have also given the totals, which are more curious than useful, except as showing the great difference existing between the rainfall of some days compared with others, when no physical reason can be assigned for such a difference.

For instance, taking the average of the two places, the rainfall on the 23rd days of the months (480 days) is 33 per cent. greater than that on the 4th, and 15 per cent. greater than that on the 22nd, or the day preceding.

Stations.	Months.	Days of the Month.														
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Cobham	January	in. 1'38	in. 1'41	in. 1'91	in. 2'81	in. 1'84	in. 1'95	in. 2'49	in. 0'98	in. 2'11	in. 2'12	in. 2'74	in. 4'75	in. 2'83	in. 2'37	in. 2'07
Chiswick	"	1'71	0'92	2'38	2'17	1'75	1'60	1'93	0'84	1'88	1'85	3'27	4'41	2'46	2'31	1'70
Cobham	February	2'97	2'03	1'83	2'39	1'71	1'00	1'56	2'22	2'17	2'34	2'00	1'35	1'94	2'53	1'49
Chiswick	"	1'77	2'53	2'27	2'33	2'33	0'84	2'07	2'56	1'63	1'66	1'72	1'47	1'60	1'83	1'43
Cobham	March	1'98	2'11	2'49	1'98	2'62	1'88	1'24	0'91	2'25	1'92	1'23	1'66	3'07	4'09	1'18
Chiswick	"	2'12	2'13	2'39	1'51	2'21	1'55	1'20	0'95	1'51	2'08	1'72	1'78	2'14	3'94	1'54
Cobham	April	3'78	2'10	1'94	2'27	1'46	1'49	2'53	2'64	2'94	0'84	2'66	2'58	1'48	1'94	2'01
Chiswick	"	2'56	3'30	1'35	2'18	2'55	1'04	2'45	2'60	2'52	1'15	1'86	2'79	1'58	1'42	1'79
Cobham	May	1'47	2'18	2'07	2'17	3'86	3'67	3'82	4'51	1'67	3'46	1'39	3'06	2'34	1'82	2'64
Chiswick	"	1'61	1'65	2'07	2'10	4'30	3'47	3'38	3'72	3'40	1'72	2'24	3'85	2'82	2'29	2'52
Cobham	June	2'05	3'35	2'44	2'66	4'94	1'62	1'98	1'29	4'61	1'58	2'31	3'41	2'49	2'18	2'55
Chiswick	"	2'11	2'94	2'51	1'64	4'50	1'54	2'34	1'20	4'06	2'65	1'97	4'73	3'55	2'63	2'16
Cobham	July	2'79	1'73	2'59	1'31	2'37	2'61	2'01	3'32	2'93	2'43	2'91	1'37	2'70	3'04	2'62
Chiswick	"	3'72	0'96	3'08	1'32	2'51	2'70	2'37	2'78	2'99	2'40	2'63	2'54	2'98	2'59	4'31
Cobham	August	1'69	3'02	4'46	2'45	2'60	1'92	3'19	1'85	2'03	4'42	2'73	1'36	5'23	6'13	2'46
Chiswick	"	3'08	6'06	3'33	2'99	3'11	2'71	3'00	2'49	2'33	4'31	3'52	1'30	5'26	5'03	2'74
Cobham	September	3'11	2'85	1'97	1'76	2'89	2'89	2'37	4'33	3'62	2'06	3'32	2'06	2'59	3'36	2'24
Chiswick	"	3'98	2'36	2'98	2'15	1'35	4'34	2'71	4'42	4'41	3'67	2'28	2'39	1'82	3'23	2'71
Cobham	October	3'66	2'16	3'07	4'21	3'10	3'53	4'81	2'89	3'60	5'30	2'55	3'17	1'78	2'27	4'35
Chiswick	"	3'31	2'04	3'18	3'89	3'81	3'63	3'36	3'70	3'49	5'32	2'64	3'14	1'14	2'53	4'15
Cobham	November	3'95	2'52	2'40	2'19	2'93	3'92	2'31	2'62	2'16	3'30	2'14	1'90	4'83	3'82	1'67
Chiswick	"	2'56	3'10	2'59	2'24	3'07	2'99	2'31	2'67	1'66	3'64	3'09	1'91	4'47	4'12	1'83
Cobham	December	1'49	2'83	1'05	2'50	2'58	2'18	4'29	2'19	1'59	1'15	2'69	2'19	1'15	1'60	2'78
Chiswick	"	1'45	2'65	1'22	1'90	1'72	2'33	3'35	2'38	1'81	0'87	1'90	1'79	0'93	1'27	2'49
Cobham total .....	.....	30'32	28'29	28'22	28'80	32'90	28'66	32'80	29'75	31'58	30'92	28'67	28'86	32'43	35'15	28'06
Chiswick total .....	.....	29'98	30'64	29'35	26'42	33'21	28'74	30'47	30'31	31'09	31'32	28'84	32'10	30'75	33'19	29'37
Total .....	.....	60'30	58'93	57'57	55'22	66'11	57'40	63'27	60'06	63'37	62'24	57'51	60'96	63'18	68'34	57'43

Stations.	Months.	Days of the Month.															
		16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
Cobham.....	January.....	in. 2.31	in. 1.83	in. 2.14	in. 2.59	in. 2.99	in. 3.05	in. 1.35	in. 1.64	in. 2.60	in. 2.78	in. 2.44	in. 2.44	in. 1.53	in. 1.83	in. 4.27	in. 2.26
Chiswick.....	".....	in. 1.99	in. 1.33	in. 2.30	in. 3.54	in. 2.79	in. 2.69	in. 1.45	in. 1.49	in. 2.40	in. 2.57	in. 2.30	in. 2.36	in. 1.49	in. 1.53	in. 2.70	in. 2.37
Cobham.....	February.....	in. 0.71	in. 1.62	in. 1.14	in. 2.94	in. 2.27	in. 1.82	in. 1.48	in. 2.23	in. 2.51	in. 2.82	in. 2.30	in. 1.39	in. 2.54	in. 0.69	.....	.....
Chiswick.....	".....	in. 0.59	in. 1.59	in. 1.28	in. 2.32	in. 2.76	in. 1.50	in. 1.33	in. 2.05	in. 2.79	in. 2.57	in. 3.38	in. 1.86	in. 2.54	in. 0.45	.....	.....
Cobham.....	March.....	in. 2.25	in. 1.84	in. 0.67	in. 0.94	in. 2.09	in. 1.80	in. 1.65	in. 1.74	in. 0.93	in. 1.17	in. 1.19	in. 1.88	in. 2.11	in. 0.87	in. 2.09	in. 2.52
Chiswick.....	".....	in. 2.63	in. 2.03	in. 0.79	in. 0.93	in. 2.60	in. 1.13	in. 1.33	in. 1.99	in. 0.67	in. 1.58	in. 0.82	in. 1.65	in. 2.79	in. 1.31	in. 1.92	in. 2.11
Cobham.....	April.....	in. 2.22	in. 1.76	in. 2.55	in. 1.53	in. 1.74	in. 1.52	in. 1.93	in. 2.86	in. 3.77	in. 2.51	in. 0.95	in. 1.46	in. 1.93	in. 2.43	in. 0.98	.....
Chiswick.....	".....	in. 2.39	in. 1.44	in. 1.93	in. 0.95	in. 1.53	in. 1.33	in. 2.47	in. 2.75	in. 2.66	in. 3.97	in. 1.18	in. 1.56	in. 1.99	in. 2.45	in. 1.07	.....
Cobham.....	May.....	in. 1.91	in. 3.04	in. 2.35	in. 2.73	in. 2.13	in. 2.37	in. 1.38	in. 2.59	in. 3.27	in. 2.28	in. 1.45	in. 3.06	in. 3.36	in. 3.79	in. 1.26	in. 2.28
Chiswick.....	".....	in. 1.47	in. 2.33	in. 1.36	in. 2.26	in. 2.80	in. 2.68	in. 1.38	in. 2.15	in. 2.70	in. 1.99	in. 2.24	in. 3.00	in. 3.63	in. 3.74	in. 1.51	in. 2.78
Cobham.....	June.....	in. 2.59	in. 2.48	in. 3.51	in. 2.40	in. 3.90	in. 1.78	in. 2.13	in. 1.89	in. 2.72	in. 2.60	in. 3.37	in. 3.69	in. 3.09	in. 0.83	in. 2.61	.....
Chiswick.....	".....	in. 1.92	in. 3.24	in. 2.79	in. 3.14	in. 2.13	in. 2.97	in. 2.28	in. 2.16	in. 2.78	in. 3.94	in. 3.93	in. 2.32	in. 3.03	in. 1.30	in. 2.44	.....
Cobham.....	July.....	in. 4.05	in. 4.06	in. 5.08	in. 3.53	in. 2.64	in. 2.74	in. 3.32	in. 4.60	in. 2.35	in. 4.00	in. 5.03	in. 3.57	in. 1.95	in. 2.74	in. 2.09	in. 2.33
Chiswick.....	".....	in. 3.38	in. 2.86	in. 4.48	in. 3.16	in. 3.13	in. 2.72	in. 3.72	in. 4.79	in. 3.73	in. 1.51	in. 4.24	in. 3.89	in. 3.10	in. 2.63	in. 4.49	in. 2.79
Cobham.....	August.....	in. 4.10	in. 2.55	in. 2.45	in. 1.54	in. 3.68	in. 3.62	in. 3.94	in. 5.10	in. 1.73	in. 3.49	in. 2.14	in. 2.49	in. 1.54	in. 2.05	in. 2.03	in. 3.17
Chiswick.....	".....	in. 3.34	in. 5.43	in. 4.36	in. 1.73	in. 2.03	in. 3.47	in. 2.94	in. 4.18	in. 1.73	in. 3.21	in. 2.28	in. 3.21	in. 1.52	in. 1.92	in. 2.64	in. 3.99
Cobham.....	September.....	in. 3.09	in. 4.21	in. 4.36	in. 3.05	in. 2.94	in. 2.56	in. 3.15	in. 3.63	in. 4.66	in. 1.58	in. 5.99	in. 5.24	in. 4.96	in. 3.65	in. 2.66	.....
Chiswick.....	".....	in. 2.76	in. 3.84	in. 3.53	in. 3.09	in. 2.48	in. 2.98	in. 3.04	in. 3.56	in. 4.04	in. 1.57	in. 5.51	in. 4.77	in. 5.93	in. 3.44	in. 3.14	.....
Cobham.....	October.....	in. 3.51	in. 1.55	in. 4.70	in. 3.21	in. 1.85	in. 3.37	in. 6.48	in. 4.81	in. 4.23	in. 4.97	in. 4.33	in. 4.22	in. 4.03	in. 3.27	in. 4.85	in. 2.93
Chiswick.....	".....	in. 3.55	in. 1.56	in. 4.38	in. 2.95	in. 2.12	in. 3.11	in. 6.03	in. 4.31	in. 3.89	in. 5.31	in. 3.34	in. 4.67	in. 4.35	in. 2.72	in. 4.44	in. 3.19
Cobham.....	November.....	in. 2.23	in. 3.26	in. 2.42	in. 2.63	in. 2.21	in. 3.36	in. 3.51	in. 3.85	in. 2.97	in. 3.65	in. 4.09	in. 3.63	in. 4.58	in. 4.17	in. 2.03	.....
Chiswick.....	".....	in. 2.02	in. 2.67	in. 2.74	in. 2.48	in. 1.60	in. 4.01	in. 2.92	in. 3.05	in. 2.92	in. 2.38	in. 3.87	in. 3.13	in. 5.17	in. 4.18	in. 2.34	.....
Cobham.....	December.....	in. 2.39	in. 2.10	in. 3.32	in. 2.24	in. 1.99	in. 0.84	in. 2.21	in. 3.15	in. 1.73	in. 1.58	in. 2.11	in. 2.00	in. 1.36	in. 1.62	in. 1.36	in. 2.23
Chiswick.....	".....	in. 2.47	in. 1.75	in. 3.00	in. 1.97	in. 1.49	in. 0.96	in. 2.29	in. 2.63	in. 1.39	in. 1.24	in. 1.87	in. 1.59	in. 1.09	in. 1.80	in. 1.14	in. 2.09
Cobham total.....	.....	31.36	30.30	34.69	29.33	29.92	28.83	32.53	38.09	33.47	33.43	36.39	35.07	32.98	27.94	26.23	17.72
Chiswick total.....	.....	28.51	30.07	30.60	28.52	27.66	29.55	31.18	35.11	31.70	31.84	34.86	34.01	30.63	27.47	27.83	19.32
Total.....	.....	59.87	60.37	65.29	57.85	57.59	58.38	63.71	73.20	65.17	65.27	71.25	69.08	69.61	55.41	54.06	37.04

ENGLAND.—Proc. No. 48, p. 118, Table XVI. for November 12-16 read 12-26: and on the 4th line, below Table XVI., for ten-day read fifteen-day.

ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Pays lines and under	0	4	0	Page	1	10	0
Above five lines, per line	0	0	4	Bills, half-sheet and less	1	10	0
Half a page	0	17	6	" whole-sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY.

SESSION 1869-70,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., at 7 P.M.

1869. November	17	1870. March	13
1870. January	19	" April	20
" February	16	" June (ANNUAL)	15

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 3s. Vol. II. £1 6s. Vol. III. £1 6s. Vol. IV. £1 6s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES.

Newly arranged, containing Corrections for Temperature, adapted to different Classes of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

"Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. Belville's Books."—*Edinburgh*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, F.R.S., SECRETARY.

1870, JUNE 15.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
XVII. Path of the Large Fireball of November 6, 1860, 11 ^h 50 ^m p.m. G. M. T.—Prof. Alexander S. Herschel, B.A., F.R.A.S.	130
XVIII. On the Temperature of the Air in Natal, South Africa, from observations taken at Pietermaritzburg (3925 feet above the level of the sea, and in lat. 29° 56' 13" S.) during the Ten Years 1855-64.—R. J. Mann, M.D., F.R.A.S., F.M.S., &c., Superintendent of Education in the Colony.	150
XIX. Atmospheric Pressure in relation to Wind and Rain.—Richard Strachan, F.M.S.	159
XX. November Meteors, 1869, in Mauritius.—Charles Meldrum, M.A., F.R.A.S., F.M.S.	161

Annual General Meeting:—

Harvey, 167; Overture: Edward William Brayley, 186; William Alexander Mackinnon, 188; Admiral Russell Henry Mannors, 199; John Mathew, 190; William Summerby, 192. Papers Read: 192; Balance-Sheet, 194 and 195; Officers and Council, 196; Resolutions, 197; Meetings, 197.

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1870, August.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

Vol. V.]

1870, JUNE 15.

[No. 50.]

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Denza*, Padre Prof. Francesco, Director of the Observatory,
Moncalieri, Italy;

Ellis, William Cuzens, Army Medical Department, *Garrison Hos-
pital, Portsea, Hants*;

Nunes, Francis, M.A., *Heathfield Lodge, Chiselhurst*;

were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society
were read.

XVII. *Path of the Large Fireball of November 6, 1869, 11^h 50^m*
P.M., G. M. T. By Prof. ALEXANDER S. HERSCHEL, B.A.,
F.R.A.S.

I HAVE been comparing together the principal observations of the
large meteor of the 6th of November last, all of which, that I
have seen, with the exception of one or two private additions to
the published descriptions, and Mr. Pengelly's correction of his
original observation, which are acknowledged in their places, are

* As an Honorary Fellow.

contained in the Proc. Meteor. Soc. vol. v. no. 45, pp. 22, 24, and in Mr. Symons's 'Monthly Meteorological Magazine' for December last.

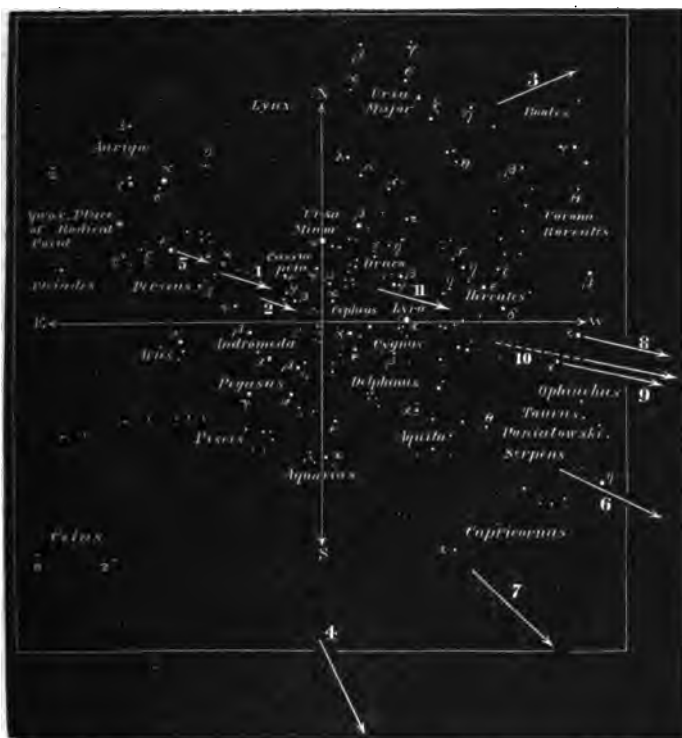
Fig. 1. *Places of Observation and Track of the Large Meteor of November 6, 1869, 6^h 50^m P.M.*



In some ten or twelve of the Reports the meteor's apparent course is described by the constellations and the principal stars near which it passed; and the remaining accounts supply sufficiently precise information to correct and confirm the resulting place which the most accurate observations agree very nearly in

assigning to the meteor's path. The accompanying two charts (figs. 1 and 2) show the positions of the observers, on a Map of England and the Channel Islands (fig. 1), at which the meteor's course and the position of the luminous streak which it left, were recorded nearly as shown in the Chart of the Constellations above the horizon at Greenwich (fig. 2), at the hour (about 6^h 50^m P.M. G. M. T.) at which the meteor appeared.

Fig. 2. *Apparent Places of the Streak of Light left by large Meteor, November 6, 1869.*



Referred to the stars at:—

- | | | | |
|------------------|------------------|-----------------|---------------|
| 1. Penzance. | 4. Bothbury. | 7. Stokeay. | 10. Ramsgate. |
| 2. Redruth. | 5. Scilly Isles. | 8. Hawkhurst. | 11. Lamorna, |
| 3. St. Helier's. | 6. Bristol. | 9. Broadstairs. | Torquay. |

The position of the persistent streak of light is generally recorded by the constellations in which it remained stationary, or across which it drifted slowly towards the west.

1. At *Penzance*, immediately after the explosion, a long train of light remained; "at that time it lay across Perseus, and moved in the direction of Cassiopeia, which it crossed. All the principal stars were visible [? through it] during its passage; the motion was from south-east to north-west, a gentle breeze from the latter point not retarding its progress; I observed this cloudy train for three-quarters of an hour, its dimensions and colour decreasing until it reached the head of Cepheus, when it finally disappeared" (fig. 2, no. 1.—Extract of a letter from Mr. Robert Blight to the Astronomer Royal, Mr. Airy). This description makes the motion of the meteor-streak to have been *from the east towards the west*. In the next observation the order of the constellations appears to be accidentally reversed, as the position of the streak in "Cygnus and Pegasus," at the time of the meteor's disappearance, was considerably *south-west* from Cassiopeia, where the streak is said to have remained at last. After continuing nearly stationary across the Milky-way in Cassiopeia, the streak probably travelled, as it was seen to do by Mr. Blight, at Penzance, to near the head of Cepheus, about the constellation Lacerta, "between the stars of the constellations Cygnus, Pegasus, Andromeda, and Perseus*."

2. At *Redruth*, fifteen miles north-east from Penzance, the meteor-streak "glided across the milky-way between the stars of the constellations Cygnus, Pegasus, Andromeda, and Perseus, and finally remained stationary for about seven minutes in the constellation Cassiopeia." Clouds appear, at this place, to have interrupted the view of its successive changes, as the phenomenon "was observed three times successively. The first appearance was at 6^h 55^m P.M.; and an interval of about four minutes elapsed between each appearance!" (fig. 2, no. 2).

3. At *St. Heliers, Jersey*, the meteor was seen as a "brilliant phenomenon near the constellation Ursa Major" (fig. 2, no. 3).

4. At *Rothbury, near Morpeth*, Northumberland, the position of the meteor was very accurately noted by Sir William Armstrong, and at the moment of extinction "it was about 12° or 14° above the horizon, and its direction was then S.S.W." (fig. 2, no. 4). If

* The observation at Lanhydrock, Bodmin, that the meteor shot "from about the constellation Delphinus due west," and therefore considerably *to the south* of Cornwall, is evidently a mistake in the name of the constellation to the stars of which the meteor was referred, for that of some other more vertical and doubtless a north-easterly group of stars; as the meteor must have shot from that direction not quite vertically over, but a little *on the north* of Bodmin.

half of the observed altitude is deducted, as recommended for eye-estimations near the horizon by Dr. Nevil Maskelyne in a 'Plan for observing Meteors,' printed at the Royal Observatory, Greenwich, in November 1783, the remaining altitude, 6° or 7° , and the direction S.S.W., agree exactly with the place of the meteor's disappearance as determined from the following accurate observations of its visible course by the stars.

5. At the *Scilly Isles* "the meteor travelled from E.S.E. to W.N.W., and . . . left a bright luminous cloud, serpentine in form, well-defined in shape, extending from the star ϵ in Cassiopeia to α in Perseus, and about 2° in width." The direction of the stars, from ϵ Cassiopeia to α Persei is exactly the reverse of that described as the direction of the meteor's motion "from E.S.E. to W.N.W." A possible explanation of this description will be given further on (fig. 2, no. 5).

6. At *Bristol*, Mr. William F. Denning noted the meteor's passage through a point "about $1\frac{1}{2}^{\circ}$ to the east of the star η Serpentis;" and "its disappearance occurred very near R.A. 18^h and S. declination 10° " (fig. 2, no. 6).

7. At *Stokesay, near Ludlow*, Shropshire (N. lat. $52^{\circ} 25'$, W. long. from Greenwich $2^{\circ} 50\frac{1}{2}'$), Mr J. D. La Touche first observed the "narrow luminous streak, of about 15° long, extending in a nearly direct line between α Capricorni and σ Sagittarii, and situated halfway between those stars" (fig. no. 7).

8. At *Hawkhurst*, Kent (N. lat. $51^{\circ} 2'$, E. long. $0^{\circ} 30'$), the meteor was seen by Mr. T. Humphrey to fall perpendicularly from the direction of α Lyræ; and it left a bright streak in its descent from α Ophiuchi to a point a few degrees above the horizon (fig. 2, no. 8).

9. Between *Ramsgate* and *Broadstairs*, in Kent, the meteor appeared to Mr. James Chapman to descend at an inclination of about 2° from perpendicular, towards the south, and the southern edge of the streak which remained upon its track almost covered the star β Ophiuchi (fig. 2, no. 9).

10. At *Ramsgate*, one or two miles south of the latter place, Mr. T. F. Stead first saw the meteor appear "just below Vega [altitude 52°] at 55° altitude, passing through arm of Hercules, and between head of Hercules and Ophiuchus, α Ras Alhague, and α Ras Algethi, exploding at 15° from the horizon; . . . trail perpendicular, but at finish turned to right hand" (fig. 2, no. 10).

The three last positions are not exactly in accordance with each other, when the great distance of the meteor and the relative positions of the stations southwards from its path are considered. In the accompanying chart (nos. 8–10, fig. 2), the streak, as seen from Hawkhurst (the most *southerly* of the three stations), is made to descend from α Herculis, the most *northerly* of the two stars α Ophiuchi and α Herculis; as seen from near Broadstairs (the most northerly station), from α Ophiuchi; and as seen from Ramsgate, a station intermediate between the other two, it is made to pass, as Mr. Cramp reports that Mr. Stead observed it, between the stars α Ophiuchi and α Herculis.

11. At *Lamorna, Tbrquay*, the position of the luminous streak, about five minutes after the disappearance of the meteor, was noted by Mr. Pengelly. "It was about 8° in greatest breadth, and 20° in length. Its longest axis was in a line from the *north-west point* of the horizon to the pole-star, from which, when nearest, it was about 20° distant. Its other extremity was very near the Milky-way, and surpassed every other part in brightness. Its poleward termination was faint, filmy, and bifurcated." In a later letter ('Nature,' Jan. 6, 1870, p. 267) Mr. Pengelly thus rectified the point of the compass in his statement of the direction of the axis of the meteor-cloud:—"Instead of 'north-west' it should have been *south-west*, or, perhaps, more correctly, S.W. by W."*

The locality of the bright streak, which remained visible after the meteor disappeared, is fixed by references of the meteor's path to the stars at Bristol and Stokesay. Had the course of the

* Accidental inversions of the compass-points present themselves in the following observations:—At *Mevagissey*, Cornwall, the course of the meteor is related to have been "about east half south;" meaning, evidently *from* about east half south. At *Padstow*, in Cornwall, the meteor is described as "a ball of fire falling in a south-west to north-east direction," by which a *north-east to south-west* direction is evidently intended. At *Wadebridge*, near Padstow, the train of light is said to have been seen "travelling in a zig-zag, or serpent form, from west towards the east;" and Mr. Pengelly also states that the direction of motion of the meteor-streak, while he observed it, was "towards the north-east." The letter from Mr. Robert Blight at Penzance, shows that the direction of motion of the meteor-streak, as long as it remained in sight, was *from south-east towards north-west*. Mr. Cramp, at Ramsgate, describes the streak as "perpendicular, but at finish turned to right hand, thus , observer (Mr. T. F. Stead) being face to west." It is difficult from these (which comprise nearly all the available) descriptions to ascertain the real motion of the light-cloud, left by the meteor at its disappearance.—[A. S. H.]

meteor's flight, as it appeared at each of these places, at Hawkhurst, Ramsgate, and Broadstairs, in Kent, and at Rothbury, in Northumberland, been continued onwards below the horizon, the meteor must have entered the sea not far from the Scilly Isles. The luminous tracks in the sky, recorded at the same places, *prolonged backwards*, would all intersect each other within a circular space 15° or 20° in width, about the stars ϵ and ζ in the foot of Perseus. At about the centre of that space the star ξ Persei appears to have been very near the 'radiant,' or perspective vanishing-point of all the apparent tracks of the meteor's course prolonged backwards, so as to fix at least approximately the direction of the meteor's flight. The inclination of its path to the horizon of a point above which it disappeared was 24° ; and its direction was from 29° north of east.

A very similar position of the radiant-point may, perhaps, be gathered from the appearance of numerous meteors seen on several evenings in the same week in the west of Cornwall*. "On Friday evening [Nov. 5th]," writes a correspondent in the daily journals at Penzance, "from $9^h 30^m$ to 11^h P.M. they were extremely numerous, and appeared to fall almost perpendicularly from the sky. Persons watched them with deep interest as they fell and exploded, apparently but a short distance above the roofs of the houses at Penzance." At the latter hour the radiant-point near ξ Persei would be 30° from the zenith; and meteors emanating from that radiant-point would appear to be falling "almost perpendicularly" from the sky, to persons who watched the latest meteors of the shower seen at Penzance, at 11 o'clock on the night of the 5th of November.

As the well-known radiant-point in Leo, of the November meteors, was, at the time when the large meteor appeared in Cornwall, about 15° below the N. $\frac{1}{2}$ W. horizon, the path of the great fireball was inclined at least 60° from the general direction of those of the November shower-meteors. But, on the other hand, it agrees very well with the position† of a general radiant-

* A paragraph from Plymouth, introducing in the 'Western Morning News' several descriptions of the large meteor of the 6th of November, 1869, states that "on both Friday and Saturday evenings [Nov. 5th and 6th] many meteors, some of them of much beauty, were seen, but not at all comparable with the one described."—['Symons's Monthly Meteorological Magazine,' for December, 1869.]

† At R.A. 64° , N. Decl. 78° (Brit. Assoc. Report, 1868, p. 403)—See this No., p. 148, for the exact direction of the meteor's path.

point of meteors in the early part of November, R.G., recognized in one of the last Reports of the Luminous-meteor Committee of the British Association as existing near the *Haiades*, and the star *Aldebaran*, in *Taurus*; and the position of this radiant-point, in *Taurus*, during the progress of the principal shower of meteors from *Leo*, on the morning of the 14th of November, has not unfrequently attracted the attention of observers of that great meteoric display. The date of maximum of the shower R.G. may, accordingly, perhaps be shown from the occurrence of the star-shower at *Penzance* on the 5th, and from the appearance of the large meteor on the 6th of November, to coincide with the period of those two days of the early part of November, on each of which large fireballs have been much more frequently recorded than corresponds with the usual rate of their occurrence on ordinary or average days in other seasons of the year.

The meteor was vertical over a line drawn from near the *Scilly Isles* to *Tiverton*, in *Somersetshire*, which, if prolonged, would pass across the counties of *Wilts*, *Berks*, *Bucks*, and *Herts* to *Saffron-Waldon*, in *Essex*. At stations nearly on that line it would appear to fall almost perpendicularly, as described in *Mr. W. F. Denning's* note of its course by the stars at *Bristol*; and as it appeared to *Mr. J. A. Cayley* there, "gliding swiftly down the sky" and "descending from near the zenith." At *Wincanton*, *Bath*, "it fell about three times the length of the streak of light left at its bursting." At *Highclere*, *North Hants*, "unlike many previous meteors, it did not traverse the heavens, *but appeared to descend immediately*, leaving behind it a long tail of pale blue light," and it disappeared at length in the direction of *Facombe*. The observers at *Hawkhurst*, *Ramsgate*, and *Broadstairs*, in *Kent*, a little southwards from its line of flight, especially noticed its perpendicular, or nearly perpendicular, descent, but with a slight inclination from the north of the zenith, remarked by *Mr. Chapman* near the latter place.

At places in the west of England, nearest to its point of disappearance, it was seen at *Barnstaple** and *Brixham*, in *North and South Devon*, respectively "descending in a westerly direction," and "taking a westerly descent;" at *Wimborne*, *Dorsetshire*, "falling from the zenith towards the west;" while in *Cornwall* it

* Drawings and times of changes of the streak are given by *Mr. Townshend M. Hall*, at *Barnstaple*, *Devon*, in 'Symons's Monthly Meteorological Magazine,' for December 1869.

passed within a few degrees of the zenith at Penzance, Redruth, Chacewater, and Callington; and appeared at Padstow "like a globe of fire falling." At Plymouth its appearance was as "a ball of fire shooting upwards, and afterwards descending from its extreme altitude." The direction of the meteor's progress at these places was generally from the east and north-east to between west and south-west, and is well represented by the real course, which will shortly be assigned to the meteor's path.

At places northwards from the meteor's track, the fireball was seen in the southern sky, travelling obliquely downwards from the east or north-east towards the south-west. Thus, at West Anstruther, Fifeshire, Mr. J. S. Phene saw the meteor nearly in the south-west travelling from N.E. to S.W. At Narberth, Pembrokeshire, the trail "extended as a band of light in an oblique direction from east to west." At Birmingham*, the meteor appeared in the south-west, "elevated about midway between the horizon and the zenith, and passed at an angle of about 48° , and with a very slight curve in a northerly direction, or nearly parallel to the plane of the equator." At Stokesay, in Shropshire, the streak of light "extended in a nearly direct line between α Capricorni and σ Sagittarii," or descended from the eastward, with a slope of 56° towards the S.W. $\frac{1}{2}$ S. horizon. At Rothbury, in Northumberland, the meteor "descended from the eastward at an angle of about 45° to the southern horizon, and at the moment of its extinction, its direction was S.S.W." The slope which the meteor's real path (as already assigned to it) would appear to have at Rothbury, was from the eastward, at an angle of 40° to the S.S.W. horizon.

The principal observations available for calculating the height of the meteor-streak are those at Bristol and Stokesay, by direct comparison of which the height of the bright streak, from about forty miles over Launceston to about twenty miles over the Cornish coast between Padstow and St. Ives, would lead to a point of immersion of the meteor in the sea, had its flight been continued onwards, very near the Land's-end. As, however, the ob-

* A murky state of the atmosphere having prevailed over Birmingham, permitting few stars to be visible, it is not surprising that the description of the meteor's course "from about the star Markab, in Pegasus, to Vulpecula," is too greatly at variance with the foregoing accounts of its track to admit of its combination with them for the purpose of obtaining the meteor's real path.—[A. S. H.]

servers at all the stations in the west of Cornwall agree in stating that the meteor pursued its course considerably to the westward of their point of view, the streak certainly had a somewhat more westerly position. At the Scilly Isles the streak extended "from the star ϵ in Cassiopeia to α in Perseus," while at Penzance "it lay across the constellation Perseus;" and it "remained stationary in Cassiopeia" at Redruth. An almost unmeasurable height of the light-cloud would evidently result from the smallness of the parallax, and the wide distance (forty to fifty miles) between these stations; but a direction towards the west of the Scilly Isles, and a termination over the sea is, nevertheless, apparent from the general position of the observations at the latter place. As the order of the stars, there mentioned, is exactly the opposite to the direction of the meteor's flight, "from E.S.E. to W.N.W.," while at a distance just as far from α Persei, and in the opposite direction to ϵ Cassiopeia, there is found the star ϵ Persei, it may perhaps be assumed that the mistake of a constellation has occurred, and that the true position of the streak, as observed at the Scilly Isles, was from ϵ Persei half-way to α Persei. This apparent place is quite compatible (while the original position does not agree nearly so well) with the observations of the light-cloud as described at Bristol, at Stokesay, and at Redruth. Supposing it to have commenced at the first place 5° above the star ν Serpentis, and prolonging its termination there 2° , while the termination at Stokesay is shortened by the same amount, displacing the whole line of the streak at the same time, as observed at Stokesay, 8° towards the west out of the "nearly direct line between α Capricorni and σ Sagittarii," the height and position of the luminous streak are very exactly fixed from forty-seven miles over a point near Launceston (N. lat. $50^\circ 36'$, W. long. $4^\circ 31'$) to twenty-seven miles over the sea, at a point near St. Ives (N. lat. $50^\circ 16'$, W. long. $5^\circ 30'$). The length of the streak was fifty-four miles; its greatest breadth, viz. $3'$, as seen by Mr. Pengelly, five minutes after the meteor's disappearance at Torquay, at a distance of eighty miles from the middle of the streak, was about four and a quarter miles; its inclination to the horizon 23° , and its direction from 29° north of east, corresponding to a radiant-point near ξ Persei, at R.A. 62° , N. declin. 37° . Had the meteor's flight continued onwards, a distance of eighty miles beyond its point of explosion, and disappearance, it would have entered the sea at a point twenty-seven miles W.S.W. from the Scilly Isles, in N. lat.

49° 47', W. long. 6° 50'. The termination of the streak, so ascertained, was due west from Chacewater (Truro), at an altitude of 60° from the horizon, or twice the recorded altitude, "80° directly west," of its point of disappearance, as noted at that place. Although the meteor's visible flight may have continued beyond the termination of its luminous streak, no grounds for such a supposition appear to be contained in any of the other observations. The points of termination and commencement of the light-cloud here assigned are, indeed, in such excellent agreement with its stationary place in Cassiopeia, as seen at Redruth, between the Pole-star and the western branch of the milky-way, as observed at Torquay by Mr. Pengelly, near the constellation Ursa Major, as seen at St. Helier's in Jersey, and a few degrees above the S.S.W. horizon, as described by Sir William Armstrong at Rothbury, in Northumberland, that no doubt whatever of its real altitude and position being situated within a little more than five or ten miles of those above found (from the most conclusive, because at the same time the nearest, and the most careful and precise of the observations) can be entertained.

The first appearance of the meteor is distinctly described at Wincanton, Bath, where Mr. T. Richards writes that "from the point where I first saw it, it fell about three times the length of the streak of light left at its bursting." Continuing the arch of the meteor's flight backwards in the sky, at Bath, to the required distance (an altitude of 51°), the point where the meteor first appeared would be seventy miles over Tiverton, in Somersetshire. But as it was seen at Ramsgate "starting from just below α Lyrae [due west, alt. 52°] at an altitude of about 55°," its visible course must be supposed to have begun somewhat earlier; and a height of ninety miles over Frome, in Somersetshire, would correspond to a visible commencement of its course at Ramsgate, 20° below α Lyrae, and 80° above the west horizon. The whole length of its flight from this point to the end of the bright streak of light was 170 miles. The duration of its flight at Ramsgate, as observed by Mr. T. F. Stead, and communicated by Mr. Cramp to Mr. Glaisher, in a Form of Registry of the Luminous-Meteor Committee of the British Association, was "4 seconds;" and the time of its transit at Chacewater was "about 6 seconds." A velocity of between thirty and forty miles per second was accordingly the real speed of the meteor's motion; and it approached very nearly to the extreme speed (about forty-two

miles per second) with which the meteors of the great November-system enter the earth's atmosphere. As long as the disturbances to which the individual meteors of that group are subject, by the action of the planets, are but little known, it would be difficult to say if the present large meteor was a very erratic member of the group; or if, as suggested by the above-determined direction of its course, it was a normal member of a less rich, but yet occasionally observed and well-established meteor-shower, with a radiant-point near α Tauri, whose maximum appears to occur on the 5th or 6th of November, or in the early part of November, not far from the date of the great shower of the November meteors.

XVIII. *On the Temperature of the Air in Natal, South Africa, from observations taken at Pietermaritzburg (2095 feet above the level of the sea, and in lat. $29^{\circ} 36' 13''$ S.) during the Ten Years 1858-67.* By R. J. MANN, M.D., F.R.A.S., F.M.S., &c., Superintendent of Education in the Colony.

In a former communication to the Meteorological Society (vol. iii p. 208), occasion was taken to allude to the physical conditions which are concerned in determining the leading characteristics of climate in the district of South-eastern Africa known as the colony of Natal. On subsequent occasions (vol. iii. p. 340, vol. iv. pp. 189, 231, vol. v. p. 123) the law of variation of atmospheric pressure and of distribution of rainfall in the same district was examined more especially and in fuller detail. In this communication the subject is pursued into an investigation of the air-temperatures of the locality presented at the different seasons of the year. As in the previous instances, the observations relate mainly to a position situated among the hills, at a height of 2095 feet above, and at a distance, in a direct line, of forty-two miles from the sea. The deductions in this case are made from a period of ten years.

In considering the question of air-temperature, it must be constantly borne in mind that the region under notice is one that is approximately tropical, Pietermaritzburg, the capital of the colony, where the observations were made, being only 363 geogra-

phical miles from the southern tropic of midsummer vertical noonday sunshine (in south latitude $29^{\circ} 36' 13''$), and that it is very remarkably placed upon the margin of a vast sun-scorched continent rising abruptly some thousands of feet out of the sea. It is so placed that the pine-apple, the banana, the sugar-cane, and coffee, ripen with the utmost facility in the open air along the lower coast region, although the grain-crops and food-productions of temperate lands can be cultivated, and cattle, sheep, and horses can be reared on the loftier ground among the hills.

The mean temperature of the year for the city of Pietermaritzburg, deduced from a period of ten years, is $64^{\circ} 67$ of Fahrenheit. At this elevation the pine-apple, the banana, and the sugar-cane are not found. But the orange ripens with great luxuriance in suitable soils, in the open air, and the gardens are gay through the season of midwinter with the bright flowers of the oleander, the braugmantia, the ipomea, the passion-flower, and the night-blowing cereus; the apple, the peach, the loquat and the grana-dilla flourish side by side in the fruit-bearing season. The vine grows readily, but needs some special care on account of the wetness of the period of ripening. The coffee bears abundant crops of berries at even this altitude, and in all probability will be yet successfully cultivated even so far from the sea. The cotton-plant is, at this present time, being propagated in the same zone of height, with considerable promise of a satisfactory economical result. The mulberry, in every variety, spreads itself with the uncontrollable luxuriance of an indigenous weed. The blue gum-trees (*Eucalyptus*) of Australia have taken possession of the soil, and attain to a height exceeding 100 feet in a little more than a dozen years. Maize is the staple production of the district, and is grown remuneratively under the rudest cultivation, most satisfactorily in these hill-regions, but also in all parts of the land from the sea-coast to the declivities of the higher mountains. It forms, indeed, the almost exclusive food of the very large native population.

In regions as nearly tropical as Natal, the extremes of opposite seasons are very considerably softened by the diminution of the length of the summer day and the diminution of the length of the winter night. Thus, in Natal, the difference of the length of the midsummer and midwinter day is only four hours. The sun only rises two hours later, and sets two hours sooner, in midwinter than

in midsummer. The midsummer sunrise is about 5, and the mid-winter sunrise about 7; and the sunset of the two seasons at 7 and 5 respectively. In the case of Natal, this softening of the opposite seasons is, however, very materially increased by the condition of rainfall, which has been already described in the records of the Society (see vol. iv. p. 189, and vol. v. p. 128): a reference to the printed account of the Natal rainfall will show that four-fifths of the annual rainfall occur in the six months of highest temperature, and one-fifth in the six months of lowest temperature; that the summer half of the year is a season of abundant and frequent rain, and comparatively predominant cloud, and that the winter half of the year is a season of scarce rainfall, and comparatively abundant sunshine. Thus the heat of the summer sunshine is moderated and lowered by the frequent interposition of the cloud-screen, and by the almost constant, and always copious, evaporation from the ground; while the heat of the winter sunshine is economized and made the most of by the opposite conditions of clear sky, and dryness of ground. In the situation of Pietermaritzburg, the capital of the colony, where the mean temperature of the year is $64^{\circ}\cdot67$, the mean temperature of the summer half of the year, extending from October to March, is $68^{\circ}\cdot4$; and the mean temperature of the winter half of the year, extending from April to September, is $59^{\circ}\cdot4$.

The mean temperature for each year of the ten-year period extending from 1858 to 1867, at Pietermaritzburg, was—

Mean Temperature.	
In 1858	64·90
1859	64·95
1860	64·43
1861	64·27
1862	64·47
1863	64·40
1864	64·50
1865	65·80
1866	65·10
1867	63·90

These mean temperatures are all derived from the daily mean of the highest and lowest readings of the self-recording instruments.

This was the only method of deduction available through this period, in consequence of the impracticability of getting, with the means at command, daily records at more than three periods in each twenty-four hours. The regular periods of observation were 9 A.M. and 3 and 9 P.M. During the years 1862, 1863, and 1864, means were taken from the three observations each day, for comparison with the means derived from self-recording instruments. It is a very remarkable fact that the mean annual temperature for each of those three years, by the three-observations-per-day method, comes out $65^{\circ}4$.

The exact comparison of the annual means for those three years, by the two methods, gave—

Mean Annual Temperatures			
	deduced from maximum and mini- mum observations.		deduced from obser- vations taken daily at three fixed periods.
1862	$64^{\circ}47$	.....	$65^{\circ}4$
1863	$64^{\circ}40$	.....	$65^{\circ}4$
1864	$64^{\circ}50$	.....	$65^{\circ}4$

The mean temperatures of the several months of the year, at Pietermaritzburg, deduced from a ten-year period of observation, extending from 1858 to 1867, was—

Mean Temperature.	
January	$71^{\circ}6$
February	$71^{\circ}8$
March	$69^{\circ}7$
April	$65^{\circ}0$
May	$58^{\circ}8$
June	$55^{\circ}1$
July	$55^{\circ}7$
August	$60^{\circ}3$
September	$64^{\circ}8$
October	$66^{\circ}1$
November	$69^{\circ}4$
December	$70^{\circ}8$

The highest air-temperature recorded at Pietermaritzburg during this ten-year period, was $97^{\circ}6$. The lowest temperature

29°. The extreme range of temperature for the ten years was therefore 68°·6.

The highest air-temperature in each year of the ten-year period was

	Highest Temperature recorded.
1858	96°·8
1859	98°·4
1860	97°·1
1861	95°·4
1862	95°·2
1863	94°·6
1864	94°·8
1865	97°·6
1866	93°·0
1867	95°·2

The air-temperature very rarely exceeded 86°, unless when the hot land-wind, or South-African sirocco, was blowing in force. Nearly all the temperatures between 68° and 98° belong properly to the influence of this hot wind.

The lowest air-temperatures for each year of the series . were—

	Lowest Temperature recorded.
1858	38°·0
1859	34°·0
1860	31°·4
1861	29°·0
1862	32°·0
1863	35°·2
1864	29°·8
1865	34°·8
1866	29°·2
1867	34°·0

The mean highest temperature for each month, for the ten-year period, was

	Mean Highest Temperature derived from Ten Years.
January	91 ⁰ ·0
February.....	91·4
March	87·4
April	84·5
May.....	79·3
June	75·2
July.....	78·2
August	84·7
September	91·6
October	90·7
November	90·7
December	92·3

The mean lowest temperature for each month was—

	Mean Lowest Temperature derived from Ten Years.
January	56 ⁰ ·0
February.....	58·7
March	52·6
April	46·3
May.....	39·5
June	35·5
July.....	33·7
August	38·8
September	43·3
October ..	48·2
November	50·1
December	56·4

During the 3652 days comprised within the ten-year series of observations, there were

103 days, or, on the average, 10 days per year, on which the thermometer rose above 90°.

417 days, or 42 per year, on which it rose above 84°.

2436 days, or 244 per year, on which it rose above 70°.

There were 109 days, or 11 per year, on which the temperature did not rise to 60°.

There were 215 nights, or, on the average, 22 nights per year, on which the temperature fell below 40°.

998 nights, or 100 per year, on which the temperature fell below 50°.

2268 nights, or 227 per year, on which the temperature fell below 60°.

There were 69 nights, or 7 per year, on which the temperature did not fall below 70°.

There were 10 nights, or, on the average, 1 night per year, in which the self-recording instruments indicated frost 6 feet above the ground.

The air-temperature in Natal is subject to frequent and sudden vicissitudes. These vicissitudes are naturally more marked at Pietermaritzburg and among the hills than in the coast region. Attention has been already drawn to the fact (p. 207, vol. iii.) that these changes of temperature occur principally between one day and the next in the summer season; and between successive days and nights in the winter season. The mean temperature of the day jumps fitfully up and down during the season of summer. The mean temperature of the day moves evenly along in the winter season; but there is then considerable difference between the temperature of the day and night, and daily range of temperature is comparatively large. The reason for this peculiarity is the frequent intervention of the cooling influence of dense cloud and rain in the season of summer; and the almost uninterrupted presence of clear skies in winter, allowing the full influence of the sunshine to tell upon the ground by day, and the full power of radiation to come into play between sunset and sunrise.

A series of comparative observations instituted in the year 1858 between the observatory at Pietermaritzburg, 2095 feet above the level of the sea, and the sea-level at the Port of Durban, gave for each month of the year the following results:—

Comparison of Air-temperature, for each Month of the Year, at
Pietermaritzburg and Durban.

Months.	Pietermaritzburg (2095 ft. above sea-level).			Durban (sea-level).		
	Highest in Month.	Lowest in Month.	Mean of Month.	Mean of Month.	Lowest in Month.	Highest in Month.
January	93°0	52°0	68°3	74°2	57	93
February	96°8	56°0	73°3	77°0	61	91
March	91°0	42°0	69°4	73°6	51	91
April	85°0	43°5	65°6	70°9	47	89
May	79°0	38°0	59°5	64°0	44	83
June	78°2	39°3	58°6	63°6	48	86
July	81°0	38°0	58°1	62°4	45	81
August	89°8	43°0	61°3	65°2	49	81
September	90°0	42°0	64°4	67°1	47	87
October	89°0	50°5	63°8	65°9	56	84
November	88°5	52°4	68°2	72°0	55	93
December	92°0	54°6	69°3	74°0	55	92

The mean annual temperature for the year 1858 was—

At Pietermaritzburg 64°9

At Durban 69°1

Giving a mean temperature on the coast 4°2 higher than that of
Pietermaritzburg, 2095 feet above the sea-level.

The following Tables give the mean, the highest and the lowest
temperatures at Pietermaritzburg for each month of the ten years
extending from 1858 to 1867 :—

The mean temperature for each month of the ten years, ex-
tending from 1858 to 1867, was—

Months.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
January	68°3	73°2	70°9	71°3	70°0	72°4	72°8	72°4	74°6	70°6
February	73°3	72°1	73°9	67°8	72°4	71°4	71°5	71°8	74°4	69°9
March	69°4	69°5	71°6	67°8	69°0	70°2	67°5	72°7	69°3	70°6
April	65°6	64°7	65°0	65°3	65°1	66°1	60°1	67°0	67°4	64°3
May	59°5	60°4	60°2	58°9	58°6	57°6	60°4	59°2	58°5	54°9
June	58°6	56°3	56°2	55°5	53°8	53°7	54°1	53°9	54°0	55°2
July	58°1	55°4	54°6	54°4	57°4	57°0	54°9	59°1	52°2	54°7
August	61°3	58°8	59°9	60°4	57°6	59°5	60°0	62°3	63°2	60°3
September	64°4	69°0	62°6	68°1	64°0	62°2	66°3	64°2	66°2	61°0
October	61°8	64°5	65°8	65°1	66°4	65°9	66°6	69°1	64°4	69°6
November	68°2	68°0	64°4	66°9	68°0	66°4	67°4	67°4	68°6	66°7
December	69°3	71°5	68°1	69°8	71°4	70°5	72°5	70°6	70°5	69°8

The highest air-temperature for each month for the ten years extending from 1858 to 1867, was—

Months.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
January	93°0	90°4	92°6	89°2	87°4	91°4	91°6	86°8	92°6	95°2
February	96°8	93°4	97°1	84°2	89°0	88°4	86°5	93°0	93°0	93°5
March.....	91°0	85°2	92°8	87°2	85°0	85°8	83°2	90°2	88°2	85°8
April.....	85°0	83°8	86°2	89°5	87°2	83°0	77°2	85°0	87°0	82°0
May.....	79°0	78°8	82°4	78°8	76°8	76°8	77°8	85°2	78°0	80°0
June.....	78°2	74°2	77°0	76°0	75°8	73°2	72°2	71°2	77°2	77°0
July.....	81°0	77°0	75°8	80°8	82°2	75°0	79°2	82°2	73°5	76°2
August.....	89°8	84°3	79°8	81°6	88°4	81°4	82°4	86°4	89°2	84°2
September.....	90°0	86°1	90°2	95°4	95°2	92°2	94°2	94°0	86°0	93°0
October.....	89°0	86°1	87°2	93°0	95°0	84°8	94°8	96°0	89°2	92°5
November.....	88°5	89°5	84°4	93°4	89°8	94°6	90°6	97°2	91°8	88°0
December.....	92°0	93°4	89°2	93°0	90°2	91°2	91°8	97°6	90°2	95°2

The lowest air-temperature for each month for the ten years extending from 1858 to 1867, was—

Months.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.
January.....	52°0	61°0	56°4	51°8	57°4	59°0	58°2	56°6	57°8	50°0
February.....	56°0	59°2	61°8	55°8	60°0	58°0	59°0	58°0	61°2	58°0
March.....	42°0	52°7	53°2	48°8	54°2	54°4	53°6	58°6	54°0	55°0
April.....	43°5	40°2	49°0	45°2	43°6	50°0	45°2	53°8	50°0	43°0
May.....	38°0	41°9	41°2	36°4	39°2	40°8	44°0	35°8	38°2	40°0
June.....	39°3	37°2	35°6	35°0	32°0	35°2	37°8	34°8	34°8	34°0
July.....	38°0	34°8	31°4	29°0	37°0	36°4	29°8	37°2	29°2	34°2
August.....	43°0	37°2	38°6	35°0	34°8	36°8	40°6	43°0	35°0	39°0
September.....	42°0	43°7	42°6	50°0	41°0	38°0	48°8	41°8	44°2	41°0
October.....	50°5	51°0	50°2	47°0	46°2	49°2	50°6	45°2	45°2	47°0
November.....	52°4	53°4	45°6	52°0	55°8	50°2	53°0	45°2	44°2	50°0
December.....	54°6	57°3	57°0	54°4	59°0	57°2	60°0	52°2	54°5	57°2

XIX. *Atmospheric Pressure in relation to Wind and Rain.*

By RICHARD STRACHAN, F.M.S.

IN June 1869 I communicated to the Society a paper "On the Height of the Barometer in relation to the Direction and Force of Wind, at London." I now propose to make that inquiry more complete by eliminating the effect on atmospheric pressure due to aqueous precipitation. From the same series of observations, having collated under each of the sixteen points of the compass

all barometer readings taken during rain, I then referred the averages to the eight principal points of the compass, and obtained the following results:—

Wind.	Pressure. inches.	Observations, with Rain.
N.	29·795	21
N.E.	29·784	40
E.	29·683	33
S.E.	29·736	16
S.	29·639	46
S.W.	29·738	99
W.	29·790	51
N.W.	29·852	15
Calm	29·937	3
Mean of all these observations	29·743	324

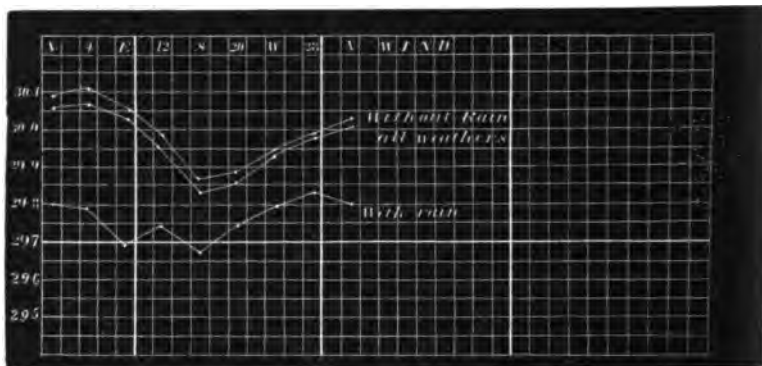
Similarly, having collated all barometer readings taken when there was no rain falling, the following results were obtained:—

Wind.	Pressure. inches.	Observations, without Rain.
N.	30·075	289
N.E.	30·109	289
E.	30·064	346
S.E.	29·981	104
S.	29·869	203
S.W.	29·883	487
W.	29·948	726
N.W.	29·993	293
Calm	30·066	87
Mean of all these observations	29·984	2824

The accompanying diagram represents the curve of pressure with reference to the wind's direction, but irrespective of the wind's force, 1st with rain; 2nd for all weathers, indiscriminately; 3rd without rain. These curves show at a glance that, for all the directions of the wind, the barometer, on an average, is highest without rain, lowest with rain; and that rains with winds from between N. and E. lower the barometer more than rains with winds from between S.W. and N.W.

Rain, considered by itself, seems to cause a change in the barometer, amounting, on an average, to 0·24 of an inch.

The strength, or force of wind, considered by itself, seems to cause a fall, or a rise, of the barometer, according as the wind increases from a light breeze to a whole gale, or *vice versa*, amounting, on an average, to 0·78 of an inch.



The direction of wind, considered by itself, exhibits a maximum pressure at N.N.E., and a minimum at S.S.W., the average difference being 0·80 of an inch.

Hence, the change of height of the barometer due to precipitation, force of wind, and direction of wind, taken together, amounts to 1·32 inches; and this agrees very well with the mean monthly range of the barometer in England.

It appears from these statistics that the barometer may *fall*, 1st, for rain; 2nd, for increase of wind; 3rd, for change of wind towards the S.S.W.; and that the barometer may *rise*, 1st for cessation of rain; 2nd, for decrease of wind; 3rd, for change of wind towards the N.N.E.

The set of three causes acting together produce the maximum effect. Thus the *lowest* pressures are observed to happen at the height of south-westerly gales which are usually attended with much rain; while the *highest* pressures occur with dry gentle breezes from the north-eastward.

According to the 'Twelfth Number of Meteorological Papers,' issued by the Board of Trade, the normal height of the barometer at Portrush is 29·138 in., while at Shields, in nearly the same latitude, it is 29·876 in.; at Galway it is 29·891 in., while at Yarmouth it is 29·940 in.; at Valentia it is 29·918 in., while at London it is 29·958 in. The west coast of Ireland has a greater annual rainfall than the east coast of England; and the excess of rain may account for the

lower pressure there. Thus, possibly, by means of good tables of the normal values of the barometer some light might be thrown upon the distribution of rain.

XX. November Meteors, 1869, in Mauritius.

By CHARLES MELDRUM, M.A., F.R.A.S., F.M.S.

ATTENTION was called to the probable appearance of the shower several days beforehand, but watch was kept at only three places, viz, Port Louis, Réduit, and Myrtle Hill.

The old Observatory having been sold, and the new one being not yet ready, most of the observations were made by His Excellency Sir Henry Barkly and Lady Barkly, at Réduit, about seven miles S. by E. from Port Louis, and by myself and some assistants, at Myrtle Hill, about five miles S. by W. from Port Louis.

At Port Louis, however, three observers were instructed to endeavour to count the meteors seen during every ten minutes from midnight of the 13th to daylight of the 14th, and to try to make out the paths of some of them. Up to 3^h 20^m A.M. only 11 meteors were counted, and from 3^h 20^m to 4^h 40^m A.M. 423—making 434 in all. Most of them shot from Leo to westward, and they varied considerably in size, brilliancy, colour, and length of train.

Sir Henry Barkly's account of the shower, as seen at Réduit, is forwarded herewith.

At Myrtle Hill we watched during the greater part of the nights of the 12th, 13th, and 14th.

From 8^h P.M. of the 12th to 1^h 40^m A.M. of the 13th, only 5 shooting-stars were seen, but up to 10^h P.M. nearly half the sky was clouded, and there was some cloud throughout the rest of the night.

Watch was again kept up from 10^h P.M. on the 13th till daylight on the 14th, and from 10^h P.M. on the 14th till daylight on the 15th; and the results are given in the accompanying Tables.

With the exception of some thin hazy clouds on the morning of the 14th, the sky was clear, with a light breeze from south-east throughout. But in the early part of the night there was too much moonlight for good observation.

The time of apparent maximum intensity of the shower was

about 4^h 5^m A.M. on the 14th; but as daylight set in soon afterwards, the real time may have been later.

The radiant-point seemed to be nearly half-way between η and ϵ Leonis.

Most of the meteors had trains, but generally short, only a few about 40° in length. They shot out in all directions, but chiefly to westward, and exhibited considerable variety in size, colour, and duration. The prevailing colour was white, occasionally tinged with green, blue, yellow, or red, and the longest duration did not exceed six seconds.

RÉDUIT, MAURITIUS, Sir Henry and Lady Barkly.

Though you, no doubt, saw much more of the star-shower (*trickle*, Lady Barkly suggests, would be more appropriate) of this morning than I can tell you, my observations are, as invited, at your service.

In the early part of the night so few shooting-stars were to be seen that we did not think it worth while to count them, or indeed to watch continuously, and it was not till about 3 o'clock that I got up and remained at my window for the purpose.

I am not quite sure of the correct time; but, by comparing my watch with one which was set by the time-ball yesterday, I imagine I am within a minute or so of the right hour. The window at which I sat faces exactly north-east, and commands a fine view of the heavens from a little to westward of north to a little to southward of east, the westernmost peak of Mount Ory bearing nearly due north from it. I could not, however, see more than 60° above the horizon, and may thus have missed seeing meteors that passed higher up in the sky. Unfortunately I know little of the southern constellations, but there were two remarkably bright stars about halfway up, just to the west of north, towards which the first meteors were directed from the east, which was the direction in which the great majority passed, though a certain number travelled apparently from west to east, or shot nearly straight up or straight down. As a general rule they might be supposed to emanate from a common centre in the north-east about 45° above the horizon; but there were a few exceptions which shot up from behind Mount Ory like rockets discharged in Port Louis. They differ much in brilliancy and length of course, some appearing to have a nucleus, while others were faint lines of light.

At first we counted but few—*eight* only in the first quarter of an hour—all from east to west. They then came quicker, and I noted from—

h	m	to	h	m	
3	15	to	3	20	... 15, a few of which were from west to east.
3	20	"	3	25	... 8
3	25	"	3	30	... 12, of which 3 west to east.
3	30	"	3	35	... 8
3	35	"	3	40	... 20: viz. 10 east to west, 5 up, 5 west to east.
3	40	"	3	45	... 16, 1 only west to east.
3	45	"	3	50	... 17, of which 12 in the first minute; 2 west to east.
3	50	"	3	55	... 20, of which 4 west to east.
3	55	"	4	0	... 33, many of them ascending to the zenith; 4 only from west to east.
4	0	"	4	5	... 27, of which 13 east to west, 14 west to east.
4	5	"	4	10	... 14, of which 8 east to west, 4 central, and 7 west to east.
4	10	"	4	15	... 7, of which 6 east to west, 1 down.

The day now began to dawn and the stars to disappear, and as the star-shower was declining, we did not stay to count any more.

It will be seen that the number altogether counted was 200 in an hour and a quarter, 192 of them within an hour. In all probability many escaped unobserved; but the display was by no means what it has been on previous occasions.

MYRTLE HILL, MAURITIUS, Charles Meldrum, M.A.

Day.	Mauritius Mean Solar Time.	Number of Meteors.	Paths, &c.
1869. Nov. 13.	h m s from 10 0 0 to 11 2 0 12 22 20 13 19 10	2 1 1	From Capella through head of Lynx. Small. From μ Geminorum towards Procyon. From near Castor towards north.
		4	

Day.	Mauritius Mean Solar Time.	Number of Meteors.	Paths, &c.
1869.	h m s		
Nov. 13.	13 30 0	1	From near Sirius towards α Orionis. Small.
	13 33 20	1	From Pollux towards Pleiades. Long train of light.
	13 43 0	1	From near Procyon towards γ Canis Majoris.
	13 43 30	1	Shot from a little to east of Castor away to eastward.
	13 45 10	1	From near Pollux towards Pleiades. Train.
	13 51 0	1	
	13 51 30	1	From " point a " few degrees " west of " Procyon towards Rigel.
	13 53 30	1	Passed from near γ Leonis towards Pollux.
	14 2 20	1	From Pleiades towards Capella. Large as Jupiter. No train.
	14 3 40	1	From δ Cancri through Canis Minor.
	14 10 30	1	From ϵ Leonis away to west. Small.
	14 12 45	1	From near γ Leonis away to south. Larger than Jupiter, with a short train.
	14 13 40	1	From μ Leonis to westward. Short train.
	14 15 0	1	Passed from near the centre of the Sickle in Leo towards α Hydrae.
	14 15 20	1	From Pollux towards β Aurigae. Long train.
	14 16 40	1	From near middle of Sickle to south-westward. Short train.
	14 18 0	1	From γ Cancri away to west. Long train.
	14 18 30	1	In the Sickle. Small.
	14 20 0	1	From near centre of Sickle to south-westward. Larger than Jupiter, with a bright train.
	14 21 30	1	From near Regulus towards Can. Venet. Large as Venus.
	14 21 50	1	Same path as preceding. Small. Train.
	14 25 0	2	From Sickle to south-westward.
	14 31 10	2	From Sickle to westward.
	14 36 15	1	From near γ Leonis to westward. Larger than Venus. A train of white light with a bluish tinge.
	14 38 0	1	From same quarter and in same direction. Small.
	14 41 20	1	From λ Leonis to westward. Small.
	14 44 10	1	From near Regulus to south-westward. Train.
	14 45 0	1	From near Regulus to westward.
	14 45 40	1	From near centre of Sickle to north-eastward.
	14 53 30	4	Three from Sickle in different directions.
	14 59 0	2	From Sickle to south-westward and westward.
	15 0 0	2	From near Regulus towards α Hydrae. 1st mag. Long trains.
	15 2 0	1	From Regulus to westward. A thin streak of bluish light.
	15 2 45	1	From μ Leonis towards Castor. Long train.
	15 6 0	4	Two from near Regulus to westward, and two seen near Crux.
	15 9 30	2	One from centre of Sickle, and one from Regulus, both to westward. Long trains.
		51	

Day.	Mauritius Mean Solar Time.	Number of Meteors.	Paths, &c.
1869. Nov. 13.	h m s		
	15 12 30	1	From near Castor towards the Pleiades.
	15 14 40	2	One from Sickle to northward, and one with long train from 5° below Castor, towards Capella.
	15 19 0	10	All from near centre of Sickle, chiefly to westward. Trains about 15°. Duration 1 to 3 seconds.
	15 20 40	1	From Leo Minor towards Capella. Small.
	15 22 0	4	Two from Procyon towards Lepus, and two from Sickle.
	15 22 40	1	From head of Hydra towards Sirius.
	15 23 10	4	From Sickle in different directions. The last of them very large and brilliant, with bluish train.
	15 25 0	1	From near Canopus away to westward. Large.
	15 27 0	5	} From Sickle, chiefly to westward. Trains of various length. Colours various, but chiefly white with a greenish tinge.
	15 30 0	6	
	15 31 30	1	From Sickle to north-westward.
	15 31 40	1	From near Capella towards Pollux. Large as Jupiter.
	15 36 30	5	From Leo, in different directions.
	15 37 0	1	From β Corvi to westward.
	15 39 30	8	Chiefly from the Sickle. One large and without train passed slowly towards Crater.
	15 43 0	14	Some from the Sickle, and many from near Pollux towards Aldebaran.
	15 46 0	18	Most of them from centre of Sickle. A few passed near Castor and Pollux. Several were contorted gleams and bands of light in the Sickle.
	15 47 30	5	From Sickle towards Castor and Pollux, except one from near Procyon, through Leo, which had no train.
	15 50 30	15	} From near centre of Sickle, chiefly to westward.
	15 52 0	6	
	15 53 0	7	} Most of these meteors shot from near the centre of the Sickle in various directions, but chiefly to westward. Many with long trains passed through Gemini and Taurus. The prevailing colour was white, sometimes with a greenish and sometimes a bluish tinge; but all the prismatic colours were observed. Some of the meteors were larger than Venus, with trains of about 40° in length; but most of them were smaller. Dawn commenced about 16 ^h 15 ^m , and by 16 ^h 41 ^m only a few stars of the first magnitude, as Sirius and Canopus, were visible.
	15 55 0	27	
	15 58 0	25	
	16 1 0	20	
	16 6 0	44	
	16 9 0	47	
	16 13 0	50	
	16 19 0	22	
	16 24 0	20	
	16 33 0	11	
	16 41 0	3	
		436	

Day.	Mauritius Mean Solar Time.	Number of Meteors.	Paths, &c.
1869. Nov. 14.	h m s		
	14 35 0	1	From a point about 3° north of Capella to westward. A train of reddish light. (Up to this time only three small meteors seen.)
	14 43 0	1	From a point half-way between Castor and β Aurigæ towards the Pleiades.
	14 55 0	2	One from γ Leonis to Castor, and one from head of Orion to Aldebaran. Trains.
	15 2 0	3	One from near centre of Sickle to eastward, and one from near ϵ Leonis to westward.
	15 13 0	3	One from Aurigæ to northward; one from near β Leonis to eastward; and one from near Procyon to eastward.
	15 14 0	1	} From near δ Geminorum to eastward.
	15 19 0	1	
	15 28 0	4	
			Two from near Procyon towards Regulus; one from near Regulus to westward; and one from near ζ Leonis to eastward. The last one of 1st mag.
	15 38 0	6	Most of them from the Sickle in different directions. Some with long trains.
	15 44 0	4	Two from near Capella (one to northward, and one large as Venus, with a yellow train, towards the Pleiades). The other two in Leo.
	15 55 0	4	From Leo to eastward and south-eastward.
	15 58 0	2	One from near β Aurigæ to eastward, and one from near Regulus to northward.
	16 8 0	6	One from near η Leonis to eastward; one from near ζ Leonis to westward; one from near δ Geminorum to eastward; one from η Aurigæ to northward.
	16 16 0	2	One with long train from γ Canceri towards Corvus, and one from between η and γ Leonis to eastward.
	16 20 0	1	Passed towards Canes Venatici from the Sickle. Yellow train. Gray daylight at eastward.
	16 27 0	0	Too clear. Left.
		41	

ANNUAL GENERAL MEETING.

1870, JUNE 15.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held, and the following Report of the Council was received and read.

REPORT.

In laying this Report before the Fellows of the Society, the Council have much pleasure in speaking to the satisfactory progress of meteorology during the past year. The following list (showing the names of those gentlemen in Mr. Glaisher's corps of observers whose observations were continuous during the year 1869) will speak to the interest taken in this science at home:—

<i>Observer.</i>	<i>Station.</i>
S. E. Hoskins, M.D., F.R.S., F.M.S. &c....	Guernsey.
M. P. Moyle, M.R.C.S.	Helston.
C. Barham, M.D., F.M.S.	Truro.
J. Ingleby Mackenzie, M.B., F.M.S.	Sidmouth.
Miss W. L. Hall.....	Eastbourne.
J. R. Mann	Osborne.
T. A. Compton, M.D., B.A., F.M.S.	Bournemouth.
W. J. Harris, M.R.C.S.E., F.M.S.	Worthing.
Thomas Challis	Wilton.
Thomas Mackrell	Barnstaple.
John Arnold, M.S.C., F.M.S.	Aldershot Camp.
Rev. R. Tyas, M.A., LL.D., F.M.S.	West Harptre.
Rev. C. H. Griffith, M.A., F.M.S.	Strathfield Turgiss.
Charles P. Russell	Bath.
Rev. Thomas A. Preston, M.A., F.M.S. ...	Marlborough College.
The Astronomer Royal, F.M.S.	Greenwich.
R. C. Cann-Lippincott, F.M.S.	Over Court.
G. J. Symons, F.M.S.	Camden Town.
Rev. R. Main, M.A., F.R.S., F.R.A.S.	Oxford.
E. Toller, M.D.	Gloucester.
Hale Wortham, F.R.A.S., F.M.S.	Royston.
Rev. W. Previt�, M.A., F.M.S.	Little Wrattling.
S. C. Whitbread, F.R.S., F.R.A.S., F.M.S.	Cardington.
Rev. Prof. J. Matthews, M.A.	Lampeter.
Rev. C. J. Steward, F.M.S.	Somerleyton.
C. M. Gibson, F.M.S.	Norwich.

<i>Observer.</i>	<i>Station.</i>
S. H. Miller, F.R.A.S., F.M.S.	Wisbech.
J. Nicol, M.D.	Llandudno.
J. Davis	Derby.
M. O. Tarbotton, C.E., F.G.S., F.M.S.	Nottingham.
The Earl of Leicester.	Holkham.
A. Mercer Adam, M.D., F.M.S.	Boston.
T. Moffat, M.D., F.R.A.S., F.G.S.	Hawarden.
J. Hartnup, F.R.A.S.	Liverpool.
T. Mackereth, F.R.A.S., F.M.S.	Eccles.
Mr. E. Peak	Hull.
Rev. S. J. Perry, M.A., F.R.A.S., F.M.S.	Stonyhurst.
J. M'Landsborough, C.E., F.G.S., F.M.S.	Bradford.
Henry Denny, A.L.S.	Leeds.
H. W. Thorns	Otley.
Fielden Thorpe	York.
H. Dodgson, M.D., F.R.A.S., F.M.S.	Cockermouth.
T. Sopwith, M.A., F.R.S., F.G.S., F.M.S.	Allenheads.
Isaac Cartmell, F.M.S.	Carlisle.
T. Sopwith, M.A., F.R.S., F.G.S., F.M.S.	Bywell.
Robert Spence	North Shields.
J. Smyth, jun., M.A., M.I.C.E.I., F.M.S.	Milltown (Ireland).
A. Forbes, F.M.S.	Culloden (Scotland).

Being forty-eight in number; of these twenty-nine are Fellows of this Society.

The following are the names of observers whose observations are not complete for 1869:—

Rev. W. Tuckwell, F.M.S., Taunton, deficient of one month, Dec.
W. F. Harrison, F.M.S., Weybridge Heath, deficient of one month, September.

Rev. J. Slatter, M.A., F.R.A.S., F.M.S., Streatley Vicarage, the observations for November could not be worked up; the rainfall, however, is complete for the year.

Henry E. Segrave, F.M.S., London, deficient of one month, June.

G. V. Vernon, F.R.A.S., F.M.S., F.A.S.L., Manchester, deficient of the months January to June (inclusive) and the month of August.

The following alterations in the list of observers took place during the year ending December 31st, 1869:—

W. S. Falls, M.D., F.M.S., Bournemouth, discontinued forwarding the monthly observations at the end of December 1868.

Rev. F. W. Stow, M.A. F.M.S., Tunbridge Wells, observations discontinued since March 1869, observer having removed to Hawsker, near Whitby.

Rev. J. P. Faunthorpe, B.A., F.R.G.S., Battersea, the observations taken at this station were so imperfect, and forwarded so irregularly, that they were rejected in July 1869.

W. Haywood, C.E., Guildhall, the observations were rejected in July 1869.

J. W. Jeans, M.R.C.S., F.R.A.S., F.M.S., Grantham, ceased forwarding the monthly observations at the end of June 1869.

J. Gledhill, F.G.S., F.M.S., Willow Hall, Halifax, removed to the Park-Road Observatory, Halifax, the observations at the former station are for the nine months, January to September.

Rev. F. W. Stow, M.A., F.M.S., Ripon (see Tunbridge Wells).

Rev. F. Bedford, M.A., F.R.A.S., F.M.S., Silloth, discontinued observing, December 31, 1868, owing to ill health.

The following new stations have been added to Mr. Glaisher's list since December 31, 1868.

Observer.	Station.	Date of commencing observations.
R. O. Cann-Lippincott, F.M.S.	Over Court, near Bristol.	Jan. 1, 1869
Rev. W. Previt�, M.A., F.M.S.	Little Wrattling.	" "
Rev. C. J. Steward, F.M.S. ...	Somerleyton Rec- tory.	" "
J.M.Landsborough, C.E., F.G.S., F.M.S.	Bradford	" "
Rev. F. W. Stow, M.A., F.M.S.	Hawsker, near Whitby.	Apr. 1, 1869

The staff of observers (at the end of March 1870) numbers fifty-eight; of these thirty-six are Fellows of this Society, and the remaining twenty-two are chiefly Fellows of other Societies.

The weekly meteorological observations from the following large towns, viz.:—Over Court (for Bristol), Birmingham, Sheffield, Liverpool, Old Trafford (Manchester), Eccles (Salford). Bradford, Leeds, Hull, and Newcastle-upon-Tyne—have been forwarded, with but few interruptions, to the Registrars-General of England and Scotland, for their weekly reports. On the 1st of January, 1870, the following stations, viz.:—Portsmouth, Norwich, Wolverhampton, Leicester, and Nottingham, were added to the list of towns from which weekly meteorological returns are forwarded to Mr. Glaisher. The results are furnished to the Registrar-General of England and also (combined with the meteorological results from the eight towns of Scotland, viz.:—Edinburgh, Glasgow, Dundee, Aberdeen, Paisley, Greenock, Leith, and Perth) to the Editor of the 'Gardeners' Chronicle' for insertion in that paper.

Turning to the papers which have been read before the Society

at the several meetings during the past year, the first is "On the Summer of 1868," by G. H. Fielding, M.D., the observations upon which this paper is based being spread over a period of five months (May to September), and were taken at Tunbridge Wells. The "November Meteors of 1869" was also the subject of a paper at the November meeting of this Society; observations were forwarded from W. H. Wood, the different observers at the Royal Observatory, Greenwich, from Prof. Herschel, at Glasgow, Rev. S. J. Perry, at Stonyhurst, A. Forbes, Culloden, and (although only brought before the Society this evening) from several stations in the Mauritius. The attention of the Fellows was next drawn to a paper by our Secretary, Mr. Glaisher, "On the Temperature and Humidity of the Air," &c. at different heights; the two subjects are dealt with separately, the temperature being the first treated, and it appears from the observations (which were conducted by observers at the Royal Observatory) that the temperature at the lower station is above that at the upper stations till between 5^h and 6^h P.M., when the temperatures at the different heights appear to be the same; after which the temperature at the upper station is above that of the lower, until they recross between 5^h and 6^h A.M. The rule which appears to govern the humidity of the air is directly opposed to that which governs the temperature; for the humidity during the day-hours is greater at the higher elevation than at the lower; from 6^h to 9^h P.M. it is sensibly the same; and during the night-hours is greater at the lower elevation. The paper by Mr. Glaisher during the last session on the "Influence of the Moon upon the Amount of Rainfall," drew the attention of Mr. Bloxam to the subject, and the results of his investigations were presented to the Society at their February meeting. Among the accounts on "The frequent Appearance of the Auroræ" is that of one of a very remarkable nature, viz. the appearance of an aurora in daylight, of which phenomenon there are but few recorded instances. "On the Fall of Rain on every Day of the Year," by Mr. Glaisher, forms the subject of the next paper; and, from the observations, which extend over a period of fifty-five years, it appears that the greatest amount of rain falls between the 260th and 280th days, and the least between the 30th and 60th days. "On the Rainfall of Natal, South Africa," by Dr. Mann, is the continuation of a paper read by him before the Society during the last session; and the paper read by Mr. G. D. Brumham at the same meeting, "On some of the Laws which appear to regulate the Temperature of Summer Months and Seasons" is also a continuation of his paper at the meeting in February 1868, the latter being a discussion of home stations, and the former being the discussion of stations abroad.

Proceedings of various Observatories.

ROYAL OBSERVATORY, GREENWICH.—By constant attention the magnetic basement has been maintained in a state of nearly uniform temperature. The daily changes are usually small, generally speaking not exceeding 1° Fahrenheit, in some few days amounting to 3° . These, however, are the ranges shown by the thermometers outside the double boxes; in the inside, it is probable that the changes are less. It is more difficult to grapple with the annual changes, especially with the rise of temperature in the summer heats; from October to May the temperature may be maintained, by attention to the gas-stove, between 59° and 62° ; but on some occasions in the summer it has exceeded 70° .

The upper declination-magnet for absolute determinations of magnetic-declination, and the three magnetometers for photographic register of small changes, in declination, horizontal force, and vertical force, are all in good order.

The earth-current self-registering apparatus, which has hitherto been placed in the western arm of the basement, nearly in contact with the south wall, and under the staircase, has been transferred to the eastern arm of the basement. The apparatus will there be more accessible; and it seems probable that the removal of the lights from the west to the east end, will tend to destroy the slight elevation of temperature which has usually been remarked at the west end. The immediate motive for this shift was, to give facility for the introduction of mechanism for imprinting simultaneous photographic hour-lines on the registering barrels.

The galvanic wires are in the same state as at the date of our last Report, and a general repair of the wires on the poles of the South-Eastern Railway has been made by C. V. Walker, Esq., F.R.S., Pres. M.S., &c., Engineer of Telegraphs for the Railway. On the earth-current wire from Angerstein Wharf to Lady Well, unusual interruptions occurred, the cause of which has never been discovered; they have, however, ceased entirely. The four earth-current wires (two going, two returning) were originally led from the Magnetic Observatory to a south-west chimney on the roof of the Octagon Room; lately the attachment has been shifted to a south-east chimney.

Careful observations have been made for assuring the identification, in the earth-current registering apparatus, of the wires which lead from the four different stations. The insulation of those wires is very good.

A plan has at length been arranged for photographic impression of hour-lines upon the photographic sheets of the three magnetometers and of the earth-current galvanometers, by the use of the existing lights, and in one instance by a special light. By these lights, lines in the proper positions can be impressed on each barrel; all that is necessary is, to uncover and cover the light at the proper times, and the requisite shades are so

arranged that all the lights can be uncovered and covered by the action of a single wire. To complete this apparatus there is now wanting a clock which shall act upon that wire; and after some experiments on the force required, the construction of the clock will be put in hand.

The systematic determination of zeros for the magnetic instruments has been carried out in the same manner as in past years, and the eye-observations are kept fully reduced. These eye-observations serve for zeros in the interruption of the photographic records. The photographic records, after being fully furnished with proper zeros, are thus treated. A division of the days of observation is made into two groups; the one consisting of days of generally tranquil magnetism, and, therefore, suitable for the determination of the laws of diurnal inequality; the other group containing those days of violent magnetic change.

For the year 1868, eleven days were originally selected as disturbed days; and this number should be regarded as the number of disturbed days peculiar to 1868, on the same scale of disturbance as that which has been adopted in preceding years. But, understanding it to be considered that the exhibition of disturbances should be somewhat liberal, twelve days of less disturbance have been added to this list: and for these twenty-three days the ordinates of the photographic curves have been measured at every salient point, and no further reduction is made. For the remaining days of the year, mean pencil-curves have been drawn, and the ordinates have been measured at every hour; and these have been grouped to obtain diurnal and other inequalities for every month, in the way in which it has been done in the reductions 1848-1857 and 1858-1863.

The reduced observations on disturbed days have not been discussed since the end of 1857.

Corrections for temperature to the indications of the horizontal-force and vertical-force magnetometers have not been applied since the year 1863, owing to the great doubt which existed as to the accuracy of the determinations. Three methods have been tried for the determination, in the first (in 1846 and 1847) the magnet under trial was immersed in water of different temperatures, and the angles of deflexion produced by this magnet under different temperatures upon another magnet were measured: in the second method (in 1864) the principle adopted for the determination was the same, only the magnet was placed under the influence of heated air: whilst in the third method (in 1868) the actual effect produced upon the magnet when in its natural working-mounting in the basement, by alternately heating and cooling the room itself, was observed. From experience it is believed that the hot-air process required greater care, especially in the maintenance of uniform temperature for some hours, than was bestowed on it; supposing due attention given to this point, it is thought that the hot-air method, as well as the hot-water

method, is trustworthy for the horizontal-force magnetometer. But for the vertical-force magnetometer only one method can be trusted, namely, the variation of the temperature of the instrument-room without displacement of the vertical-force-instrument from its bearings: a process analogous to that used many years ago by Sir E. Sabine for determining the thermometrical correction of pendulum-observations. When it is considered that the whole statical force of terrestrial magnetism upon a large magnet does not exceed four or five grains, it is evident that an untraceable thermal effect upon the mechanical mountings of the magnet may produce a disturbance in the conditions of equilibrium far exceeding that produced by the trifling modification in that force of four or five grains. If, for instance, the principal pinch of the magnet in its carrier is slightly excentric, the unequal thermal expansion of its two arms will so disturb the balance as completely to vitiate all results deduced by the aid of purely magnetic corrections.

The earth-current records have not been reduced since the new positions of the wires were adopted.

The dip-instrument is in good order, no observations have yet been made at the different hours of the day. The mean dip for 1869 is about $67^{\circ} 54' 36''$. But as the apparent result for dip depends (for mechanical reasons) on the dimensions of the needle, the following statement may be interesting:—

Mean dip, 1869, given by 9-inch needles	$67^{\circ} 52' 40''$
" " " 6-inch " 	$67^{\circ} 54' 37''$
" " " 8-inch " 	$67^{\circ} 56' 30''$

The deflexion instrument is in a good state. The mean value for the horizontal-magnetic force for 1869 found by its use is 3.860 (English units) or 1.783 (metrical units).

The meteorological instruments (barometer, thermometers dry and wet, thermometers in the ground and in the Thames, Osler's and Robinson's anemometers, pluviometers at different elevations) remain in their former state, with the following exceptions. One of Adie's barometers, the fundamental action of which is similar to that of the aneroid, but with flat bulb of glass instead of metal, has been procured; it has hitherto been used but little. The clock-work which carries the photographic cylinder for the dry-bulb and wet-bulb thermometers has been so altered as to effect the revolution in fifty hours instead of forty-eight hours; this is for the purpose of completely separating the traces of the two instruments. The use of the Dreadnought Hospital Ship in the Thames has ceased, and the Observatory-thermometers attached to it, for record of the temperature of the water of the Thames, have been lately removed. It is possible that they may be connected with some other ship of the Government.

Some years ago there was mounted for public view a barometer, exhibiting the changes of atmospheric pressure on a rather large scale, and it has been wished to exhibit thermometrical changes

in the same manner; but an instrument has not yet been arranged satisfactorily.

All the meteorological instruments have been constantly used, by eye or for self-registration, according to the adaptments of their construction. The assemblage of their results contains the most perfect meteorological record, except only in atmospheric electricity, available either for civil or for scientific purposes, that it appears possible to obtain. Their records are brought to the following state:—the records of the two anemometers require no addition of scales. The eye-observations of all the other instruments are completely reduced, and the dew-point and the degree of moisture are inferred, from the dry and wet thermometers, to the present time. Time-scales have been attached to the photographic curves of the barometer and the two thermometers and the new base-line of the barometrical register is drawn to the end of 1869: no base-line is required for the thermometrical registers, as the wires upon the thermometer-tubes give a negative photographic record at every degree.

The number of rotations of the vane in 1869 was +4.9.

The meteor-shower on 1869, November 13-14, was partially observed through clouds.

In our last Report allusion was made to a proposed systematic reduction of the meteorological observations during the whole time of their efficient self-registration, and this reduction has been commenced with the photographic registers of the thermometers, dry-bulb and wet-bulb, from 1848 to 1868. The ordinates of the dry-bulb thermometer through this whole period, and those of the wet-bulb through more than half of the whole, as also the corresponding eye-observations (giving zero-corrections) for the whole time, are entered into proper printed forms; and facilities are arranged for summing them through any arbitrary periods. These periods will be determined by considerations of winds and other general meteorological phenomena: a small portion have already been marked off.

ROYAL OBSERVATORY, EDINBURGH. Prof. C. Piazzi Smyth, F.R.S., &c., Astronomer Royal.—In the course of the past year the observations from fifty-five stations of the Scottish Meteorological Society have been computed here, and published, together with short discussions and references to the similar records during fourteen years past, in the Returns of the Registrar-General for Births, Deaths, &c. in Scotland.

A special work of the Edinburgh Observatory's own has likewise been completed, viz. the reduction on a uniform plan and discussion with a view to detecting *cycles* of temperature other than the annual ones, in the observations of earth-temperatures carried on here from 1837 to 1869 inclusive, by means of four large and two subsidiary thermometers.

Of such cycles many were found very distinctly marked, some longer, but more shorter, than a year. Neglecting the latter, because such dark instruments as thermometers cannot distinguish between petty local weather changes and external cosmic influences,—the former (or cycles of longer duration than a year) were specially examined: and when amongst three such cycles, one of them was found to have been repeated three times over within the limits of the Edinburgh observations, and to have a period of 11.1 years, or similar to that of the *visible* phenomenon of the solar spots,—it was considered that an important insight into weather influences had been obtained, and one which immediately proves that changes both periodical and secular are continually going on in the light- and heat-emitting power of the sun,—changes which, though astronomers have mostly been ready enough to admit the possibility of, yet geologists, as a class, have been set dead against, and have ever been ready to invoke any and every other power in nature for changing terrestrial climates, rather than an alteration of the intrinsic heating-power of the sun.

This, however, must now be allowed, if the above observations, already submitted to the Royal Society of London, in full, for the special purpose of being criticized, are found to be efficient.

A third work bearing on meteorology performed at Edinburgh, has been a private one of the Director of the Observatory there, and has been communicated to the Royal Scottish Society of Arts. It consists mainly in a new projection of the sphere for maps of the world, wherein the relative sizes of all parts are the same as on a sphere. Hence it is well adapted to represent these things or influences in the world which go by surface; and amongst these are given, one map of the distribution of terrestrial temperature, and another of the barometric pressure; the latter, however, not being reduced, as in the usual manner, to the cold outside temperature of 32° Fahr., where no man observes his barometer, but to the temperature of 68° Fahr., which is shown, from a variety of considerations and measures, to be the ruling temperature of the whole world, and the mean of all the inhabited and inhabitable parts thereof; and a safer standard, too, for all reductions being made to.

Some remarkable results are also brought out, showing that the *meridian* of highest development of terrestrial temperature passes through the true central point of all the land-surface of the earth; and that that surface is also *so* distributed in the two hemispheres, that its mean is not in the north and south, or on the equator, which would be at the maximum of heat, but in latitude 30° north, or on one of the two parallels of the world's ruling temperature of 68° Fahr. And this arrangement, it is believed, has held sensibly true throughout the whole human period on the earth,—though in earlier geological ages the distribution of land and water over the globe may have been extremely different.

ROYAL OBSERVATORY, DUBLIN. Prof. G. Brünnow, A.R.A.S., Astronomer Royal.—The meteorological instruments, consisting of barometer and dry and wet thermometer, are read here twice a day, at 9^h A.M. and 9^h P.M., when also the direction and force of the wind is noted down; there is also a daily observation of the maximum and minimum of temperature and the amount of rainfall.

These observations are not presented as the regular work of the Observatory, but have been kept up as a work of love by the Assistant. There is, however, a meteorological observatory in the Park of Trinity College, which is not connected with this Observatory. Only the anemometer, which was formerly on one of the College buildings, has now been erected here, and has been altered so as to register the forces as well as the direction of the wind; but owing to several accidents which have happened to it since its erection, it has not been in regular use for any length of time.

KEW OBSERVATORY. Balfour Stewart*, M.A., LL.D., F.R.S., F.M.S., &c.—The Kew Committee have undertaken to inspect the curves of the various observatories according to the method laid down in the last Report, and also to make one or two occasional experiments which may be desired by the Meteorological Committee of the Royal Society.

Besides the inspection of the curves and tabulations from the various observatories, a few absolute observations with Regnault's hygrometer have been made, with the view of testing the indicator given by a wet and dry bulb.

A large-sized and a small-sized anemometer, of Robinson's plan, have also been compared, in order to see if there be any considerable difference between the two. The daily meteorological observations are taken as usual.

RADCLIFFE OBSERVATORY, OXFORD. Rev. R. Main, M.A., F.R.S., &c.—The meteorological department of this Observatory has continued in the same state, and the observations have been made with the same regularity as in former years; the reduction and discussion of the observations, which are attended with considerable labour, have not fallen behindhand, with reference to former years; but it has been found impossible, with due regard to the astronomical reductions and the other duties of the Observatory, to gain much upon them. The observations for 1866 were published in the summer of 1869, and the succeeding volume

* Since appointed to the Professorship of Natural Philosophy at Owens College.

is very nearly ready at the present time, April 1870, and will probably be published before midsummer.

During the past year very great pains have been taken in the determination of the true temperature of the air by comparison of the readings of the maximum and minimum thermometers with similar instruments on the top of the towers, simultaneous readings of them (above and below) being frequently taken, to prevent any inaccuracy which may arise from the difference of their zeros on their scales. A thermometer with wet-bulb (read every morning at 10^h A.M.) has also, during the last year, been placed at the top of the tower, for the purpose of comparing the moisture of the air at that elevation with the moisture near the surface.

The anemometer during the year has never failed, or been broken, during the series of violent winter gales, so that very good means exist for comparing the different elements with those observed at other places.

CAMBRIDGE OBSERVATORY. Prof. J. C. Adams, LL.D., F.R.S., &c.—The observations taken at this Observatory during the past year, consist of daily readings, at 9^h A.M. and 3^h P.M., of the barometer, dry- and wet-bulb thermometers, and maximum and minimum thermometers.

The velocity of the wind as registered by anemometer, and the direction from a graduated circle attached to the vane.

The rain as measured by one of Casella's gauges.

The observations have been reduced by 'Glaisher's Hygrometrical Tables,' and a weekly record sent to the 'Cambridge Chronicle,' likewise a yearly summary, with full particulars relative to the rainfall, to Mr. Symons.

The new maximum and minimum thermometers, mention of which was made in last year's report, have acted very satisfactorily throughout the year.

In order to prevent the formation of ice in the interior of the case containing the wheel-work of the anemometer, three small channels were made on the floor of the case, to allow the water collected from the deposition of moisture to run out, since which no interruptions have taken place in the record of observations.

The erection of a new thermometer-stand is contemplated.

Several grand displays of auroræ have been observed.

Meteors have also been very carefully observed.

LIVERPOOL OBSERVATORY. John Hartnup, F.R.A.S., &c.—In the meteorological department of this Observatory, the standard barometer has been read daily at 9^h A.M. and 3^h P.M. for the purpose of comparison with the barograph, and the results deduced from the latter have been tabulated for each hour of the

day; all these hourly barometrical observations have been corrected for temperature and reduced to the level of the sea. Maximum, minimum, and dry- and wet-bulb thermometers have been read daily at 9^h A.M.; the amount of rain collected in a gauge placed 6 inches above the surface of the ground has been registered daily at the same hour. The velocity and direction of the wind, and the rainfall have been tabulated for each hour of the day from the anemometer sheets. Meteorological results have been published weekly, containing the following information; The highest, lowest, and mean pressure of the atmosphere from hourly readings of the barometer for each day; the highest, lowest, and mean temperature, together with the mean on the same day from an average of twenty years; the mean daily temperature of evaporation; the general direction, the extreme pressure, the greatest, least, and mean hourly velocity of the wind; the daily amount of rain which fell and the time occupied in falling, and the number of hours during the week that the wind blew from each of sixteen points of the compass.

THE COLLEGE OBSERVATORY, STONYHURST. Rev. S. J. Perry, M.A., F.R.A.S., F.M.S., &c.—The usual meteorological and magnetic work has been carried on without interruption during the past twelve months at this Observatory.

Being one of the seven meteorological stations of the Board of Trade, it is provided with the full complement of self-recording instruments, viz. a barometer, a hygrometer, and an anemometer; as also standard instruments to be read at short intervals in order to check the photographic records. Hourly readings of the barograms, thermograms, and anemograms, as well as the tabulated maxima and minima are forwarded weekly to the Central Committee.

Independently of the above, the series of observations, extending over an interval of twenty-three years, is still continued with the instruments formerly in use. These observations consist of readings of the barometer and hygrometer, and determinations of the wind, cloud, and rainfall, at 9^h A.M. and 9^h P.M. The self-registering maxima and minima are read at 9^h A.M., and the clouds are now observed several times during the day. A second rain-gauge is examined once a month to serve as a check on that which is measured twice a day, and a Crosley's self-recording instrument is also in use. The electrometer is only of occasional service in determining the nature of the electricity or the length of the spark.

The barometer and thermometers made use of in these observations have all been carefully compared either at Greenwich or at Kew.

The magnetic department vies here in importance with the meteorological. The ceaseless variations of the declination, horizontal force, and vertical-force magnets are all recorded on the pho-

tographic curves, and the absolute values of the magnetic elements are determined monthly by aid of Barrow's dip-circle, and Jones's unifilar.

A monthly summary of the meteorological results is printed for private circulation, and to this are added yearly tables of the magnetic and meteorological means. The daily mean values also appear in the '*Nouvelles Météorologiques*' of the Meteorological Society of France, and monthly and yearly tables of particular results are sent regularly to those who are engaged in the pursuit of any special branch of meteorology or magnetism.

The extra work of the year has been mainly the reduction of magnetic observations.

A magnetic survey of France was undertaken with the instruments in ordinary use at Stonyhurst, and was completed during the summers of 1868 and 1869. The west was visited in 1868, and the results embodied in a paper printed for the '*Philosophical Transactions*' of 1870. The observations taken in the east in 1869 are still in process of reduction, and will shortly be presented to the Royal Society.

A series of seven years of the monthly determinations of the magnetic elements observed at Stonyhurst has also been reduced; but a change of station, and certain corrections not yet determined with sufficient accuracy, will delay its appearance for a short time.

A comparison of the Kew and Stonyhurst magnetograms has been the subject of a short paper in the '*Proceedings*' of the Royal Society; and a preliminary comparison of our declination curves with those of Professor Donati, of Florence, has likewise been made.

Lastly, four solar radiations were read on every favourable occasion during a period of several months, to determine whether the various tints of the bulbs would give higher readings than an ordinary solar radiator blackened with oxide of manganese.

RAINFALL-INVESTIGATIONS.—The organization adopted more than ten years since for uniform registration and publication of rainfall observations, under the superintendence of Mr. Symons, F.M.S., is in effective operation, between 1500 and 2000 observers being now working together. It would not be in accordance with our usual practice to enter at any length upon the results of what may be called routine or ordinary registration, especially as they are regularly published in '*British Rainfall*' and in the '*Reports of the British Association.*' We shall, therefore, merely touch upon some of the extra work and experimental investigations of the past year.

In the summer of 1863, Colonel Ward, F.M.S., of Calne, commenced a very elaborate series of experiments as to (1) the relative

indications of rain-gauges of various sizes, and (2) of gauges at various heights above the ground, which were continued until his removal from Calne in the beginning of 1868. He then lent the gauges to the Rev. C. H. Griffith, M.A., F.M.S., of Strathfield Turgiss, Reading, who had previously a series of gauges constructed of various materials (the indications of rain-gauges vary according to the nature of the receiving surface), and thus the three sets, amounting to nearly fifty gauges, were all collected together. After two years' work at Strathfield Turgiss, the observations there and at Calne were thoroughly worked up (see 'British Association Report,' 1869). The extreme desirability of repeating the experiments in a very windy place was pointed out in the Report, and had hardly been published before the Rev. F. W. Stow, M.A., F.M.S., of Hawsker, near Whitby, offered to take charge of such of them as might be desired. Situate on elevated ground on the north-east coast, Mr. Stow's anemometer returns simply confirmed the force of the wind which one would expect in such a locality, and hence his offer was cheerfully accepted, and nearly all the gauges were sent down to him. He has very judiciously supplemented them by a horizontal and vertical-mouthed gauge for determining the angle of falling rain. The arrangement is very similar to those used by Mr. Chrimes at Rotherham, full description, with engravings, of which are given in 'British Rainfall,' 1869.

During last autumn, every gauge in Cornwall and the Scilly Isles, and most of those in Devonshire, were visited and examined by Mr. Symons.

About fifty new gauges were started during the past year in different localities, most of them being important ones, some particularly so,—*e.g.* Dartmoor, five gauges at various elevations up to about 1700 feet; Central Wales, six stations up to 2000 feet; Westmoreland, duplicate (or check) gauges, at one or two places about 1500 feet high: several new ones in Scotland, one of them, we rejoice to say, in Glen Sligachan, believed to be the wettest spot in Skye, and a close rival of Scathwaite and The Styne.

Attention has been drawn by Isaac Fletcher, M.P., F.R.S. (in 'British Rainfall,' 1869), to a correction applicable to the mountain-gauges established and maintained by him in Cumberland, whereby he arrives, and Mr. Symons expresses concurrence, at the startling result that "It seems highly probable that the average annual fall on The Styne would, if measured daily, amount to no less than from 200 to 210 inches."

TEMPERATURE OF THE EARTH AT GREAT DEPTHS.—The experiments at the deep bore at the foot of Highgate Hill have been continued by Mr. Symons, F.M.S., up to the present time; the *interim* results quoted in our last Annual Report have been most remark-

ably verified, so much so, in fact, that there is not a difference of more than one or two tenths of a degree between successive experiments at depths of 500 feet and upwards. The surface-temperature being assumed as 49° , and that at 1100 feet, 70° , we find the mean rate of increase downwards is 1° for 52.4 feet. All the observations at 1100 feet are between $69^{\circ}.7$ and 70° , *i. e.* within three-tenths of a degree, which, considering the circumstances, for example, that the thermometers have to be raised nearly a quarter of a mile before reading-off, is a degree of accuracy Mr. Symons did not hope to attain.

NORWICH METEOROLOGICAL SOCIETY.—The British Association for the Advancement of Science held its Annual Meeting in Norwich, in August 1868, and after defraying all expenses, the Local Committee had a balance in hand of a little more than £300. At a meeting of the subscribers, £100 of such surplus was voted for the purchase of meteorological instruments, and vested in the names of three trustees, viz. Mr. Gurney Buxton, the Rev. Joseph Crompton, M.A., F.M.S., and Mr. C. Mends Gibson, F.M.S.

The trustees met at Messrs. Gurney's Bank on the 3rd of December, 1868, and resolved to form a Society to be called "The Norwich Meteorological Society," and to invite certain gentlemen interested in scientific pursuits to form a Committee to make the necessary arrangements.

At the first Meeting of the Committee, Mr. Gurney Buxton kindly consented to be President, and it was determined to erect an anemometer in a suitable position; application was made to the Town Council for leave to place the instrument on the top of the Free Library, which was readily and courteously granted. An order was at once given to Messrs. Negretti and Zambra, of London, for a first-rate anemometer. Mr. Glaisher, F.R.S., who had been informed of the intention of the Committee, most kindly offered to give all needful information on the subject, and to advise with Negretti and Co. in the making of the instrument,—one that should register on the *same* chart, the velocity of the wind as recorded by Robinson's cups, and the direction and amount of pressure, and self-acting rain-gauge by Osler's apparatus. Such an anemometer was made, and placed in the commanding position chosen for it, in the month of June 1869; for a time it worked tolerably accurately, but ere long it became out of order, and if it had not been for the great interest taken in its erection and working by an active and scientific member of the Committee, Mr. James Newbegin, great expense and inconvenience must have been incurred in making the necessary alterations: it was not until the end of last December that the anemometer could be considered in proper working order; but the Society may now be congratulated upon having a superior and unique instrument, which is daily recording every movement and direction of the wind with perfect

accuracy, returns of which are regularly supplied to the Registrar-General every month with the daily readings of the barometer, thermometer, and rainfall. The President, Mr. Gurney Buxton, generously presented the Society with a complete set of valuable thermometers, which had been compared with the standards at Greenwich, and their index-errors ascertained by Mr. Glaisher. Meteorological observations have been carefully recorded in Norwich for the last thirty years by the late Mr. William Brooke, F.M.S., and since his decease by the Hon. Sec. of the Norwich Meteorological Society (Charles M. Gibson, F.M.S.) and the Assist.-Sec. The Norwich Meteorological Society now numbers forty-nine members, and may be considered to be fairly established.

A paper was recently read before the Royal Society by Commander Davis on the effect of Pressure on DEEP-SEA THERMOMETERS.

He says, it was reasonable to suppose that as the action of a thermometer was affected *in vacuo*, an opposite effect would be had by placing the instruments under pressure, the more especially as in the one case the pressure of only one atmosphere, or 15 lbs. to the square inch was removed, while in the others the atmospheres would have to be considered by hundreds, and the pressure by tons: (on this point we were not without actual observations; for Mr. Glaisher, during the year 1844, in some experiments made on the temperature of the Thames near Greenwich with delicately constructed instruments, found that the indications of temperature were affected by pressure on the bulb of the thermometer, and that at a depth of only 25 feet, or about three-fourths of an atmosphere, the readings were increased by 2°).

It was, therefore, suggested to the Hydrographer that experiments should be made to ascertain:—

1st. The effect of pressure on thermometers used for deep-sea purposes.

2nd. To obtain a scale whereby observations made by the thermometers now in use could be corrected for pressure.

3rd. To obtain a scale whereby observations made previously by other thermometers can be utilized.

It was also suggested that Commander Davis, R.N., might be placed in personal communication with different makers in respect to the best construction for the purpose required, and that a series of experiments should be made by placing some thermometers in a hydraulic press in conjunction with one in a hermetically-sealed iron bottle (as a standard), and subjecting them to pressure; also, that they should be kept under pressure a sufficient time to allow the thermometer within the bottle to take up the temperature without.

In accordance with this, instruments were obtained from Messrs. Elliott, Casella, and Pastorelli.

A difficulty arose in respect to a hydraulic press: the use of some in London could not be obtained, and others were not adapted to the purpose, so that the testing was deferred, and some of the instruments were sent to H.M.S. 'Gannet,' then deep-sea sounding on the edge of the Gulf-stream; and, afterwards, some to H.M.S. 'Lightning,' for her dredging cruise.

On the return of these vessels, the conflicting nature of the temperatures obtained from those supposed to exist, as derived from observations in other localities, rendered the necessity of ascertaining the nature and amount of error due to pressure the more imperative.

At this juncture Mr. Casella, F.M.S., who, being much interested, although believing that pressure would neither affect the thermometers or their results, undertook to have a testing apparatus constructed, at his own expense, capable of producing a pressure of three tons to the square inch.

Dr. Miller, V.P.R.S., proposed encasing the free bulb in an outer covering of glass containing air, in order to permit the lighter fluid (air) being compressed without affecting the bulb within; and one such was directed to be made; but instead of the outer casing being filled with air, it was nearly filled with alcohol, which being heated, to reduce the quantity of air, the bulb was then hermetically sealed. It was not known at the time this was proposed that a thermometer constructed on the same principle was in the instrument-room of the Meteorological Office, made originally at the suggestion of Mr. Glaisher, F.R.S.; but as the inclosure of this instrument was nearly filled with mercury instead of spirit, and also different in form, the one proposed by Dr. Miller has been called the "Miller pattern," to distinguish it.

It was also decided to test them at pressures varying between 0.12 to 3.05 tons on the square inch, these being the pressures at the depths of 250 and 2500 fathoms respectively.

On the 4th of May, 1869, the hydraulic testing-apparatus was first used, the instruments to be tested being first compared in air, and one of them was then placed in an iron bottle. They were then subjected to a pressure equal to 250 fathoms, which was kept on for two hours.

The results of this experiment were *nil*, as regards the readings of the instruments, the iron bottle being found useless; and a difficulty was also found in reading-off and resetting the indices quick enough to prevent alteration taking place before re-immersion in the cylinder. A "Miller-pattern" thermometer was eventually used as a standard; for after being subjected to a pressure of 4032 lbs. (= 1480 fathoms) for a quarter of an hour, the mean difference was only $0^{\circ}.95$.

Several experiments were then conducted with the hydraulic press, and the following Table shows the errors of the different instruments:—

	250 fathoms.	2500 fathoms.
Miller's-pattern thermometer	0°143	1°43
Casella's thermometers	1°307	12°27
Pastorelli's thermometers	1°482	12°52

ST. PETERSBURG.—The Central Physical Observatory of St. Petersburg has just issued its volume of 'Meteorological Annals' for the year 1865, and in the Preface to that volume, the Director (M. Wild) adverts to the causes which have delayed the publication of the annual volumes.

Until the year 1864, the publications of the Observatory were embraced under three heads, viz. 1. The Annals of the Observatory, which contained the details of the reduced values of the magnetical and meteorological observations made at ten principal stations. 2. The Meteorological Correspondence, giving the daily, monthly, and quarterly means of observations made at a certain number of stations: and 3. The Annual Summaries which reported upon the works of the Observatory, and gave a succinct account of the magnetical and meteorological observations made in the Empire, accompanied with remarks relating to stations newly established or re-organized, &c.

The former of these publications has been published for the years 1847 to 1864, the two latter extend from 1850 to 1864.

Upon the death of M. Kupffer, in 1865, his successor, M. Kämtz, having intended to alter the mode of publication, did not proceed with the issue of these volumes after that for 1864, and M. Wild on succeeding to the directorship in September 1868, found that no progress had been made, nor could he find any record with regard to the plans of M. Kämtz. Under these circumstances it was thought desirable to issue the volume for 1865 as speedily as possible, in the old form, omitting for the present the magnetic observations. To expedite the issue of the volume, the plan which had been conceived of publishing the meteorological results under the metric system was necessarily abandoned; but from 1870, this system will be introduced as soon as possible at the meteorological stations, and in all cases thenceforth the metrical measures will alone be employed in the publications of the Central Physical Observatory.

NATAL, SOUTH AFRICA. Dr. R. J. Mann, M.D., F.R.A.S., F.M.S., &c.—Daily observations of temperature, rainfall, direction of the wind, and leading features of atmospheric change have been made, as usual, at Dr. Mann's Observatory at Pietermaritzburg through the past year. Comparative observations have also been recorded through the year, near the level of the sea, at Durban, the port of Natal. It has not been possible under

Dr. Mann's prolonged absence from the colony to make these observations as extended and complete as they were in the early years of the series, which are now being completely abstracted for a term of ten years. But it is still purposed, with the advance of the colony, to make some more adequate provision for systematic and extended observations of meteorological phenomena.

CEYLON.—In our Report for the Session ending June 1868, mention was made of the establishment of nine meteorological stations in this island. By the end of March of the present year, however, the number has been increased to twenty-seven. Their names are—Colombo, Ratnapura, Puttalam, Anurádhapura, Mannár, Jaffna, Trincomalee, Batticaloa, Hambantota, Galle, Kandy, Nuwara Eliya, Badulla, Horakele Estate (Chilaw District), Kégalla, Dambulla, Teldeniya, Rugam, Toppúr, Pusselláwa, Vegeriya, Ramboda, Irakkámam, Sudu Ganga, Pendleton, Wiháragalla, and Nugetenna Medamaha. Of these, thirteen stations return the readings of the barometer, maximum and minimum thermometers, hygrometrical readings, readings of terrestrial and solar-radiation thermometers, the mean daily amount of cloud, ozone and horizontal movement of the air, the general direction of the wind for the month, and the daily rainfall. The remaining fourteen stations furnish returns of the rainfall only. At thirteen stations the highest recorded temperature in the shade at any station (during the period from May 1869 to March 1870 inclusive) was $98^{\circ}4$, in May 1869, at Trincomalee, 175 feet above the level of the sea; whilst, in the sun, it reached 178° , at Bodulla, 2220 feet above the sea. The greatest fall of rain in twenty-four hours, viz. 6.66 inches, was registered at Puttalam, 11 feet above the sea, on the 15th–16th of November, 1869; whilst the greatest monthly fall, viz. 25.20 inches, was registered at Peacock Hill, Pusselláwa, 3200 feet above the sea, in the month of October, 1869. The horizontal movement of the air during the same period appears to have been very variable at different stations; for whilst at Puttalam, the mean daily movement for the month of May 1869, was $578\frac{1}{2}$ miles, at Ratnapura, 114 feet above the sea, it did not amount to more than half a mile per day, in the same month. The returns are printed in monthly sheets, the whole being under the direction of Capt. Fyers, R.E., Surveyor-General.

NEW ZEALAND.—There are now eleven meteorological stations in this colony under the direction of Charles Rous Marten, F.M.S. At several of the stations the observations extend over a period of more than six years, and consist of readings of the barometer, maximum and minimum thermometers, terrestrial and solar-radia-

tion thermometers, observations of the rainfall, wind, and cloud. The names of the stations are:—Mongonui, Auckland, Taranaki, Napier, Wellington, Nelson, Christchurch, Bealey, Hokitika, Dunedin, and Southland.

The following Table shows the progress of the Society from the 13th to the end of the present Session; and it would greatly facilitate the correction of the List of Fellows, if all corrections, resignations, &c. were forwarded to our Secretary, Mr. Glaisher, at Dartmouth Place, Blackheath.

Session.	Fellows.			Totals.	Increase or Deficiency.
	Life.	Ordinary.	Honorary.		
13th Session.....1861-62	27	203	11	241	
14th " 1862-63	32	240	10	282	+41
15th " 1863-64	54	236	10	300	+18
16th " 1864-65	...	...	...	...	} +28
17th " 1865-66	56	262	10	328	
18th " 1866-67	57	264	10	331	+ 3
19th " 1867-68	66	255	7	328	- 3
20th " 1868-69	65	258	7	330	+ 2
21st " 1869-70	69	264	8	341	+11

The Society has to regret the loss of several of its Fellows; the deceased Fellows are:—

Prof. ED. WILLIAM BRAYLEY, F.R.S., F.R.A.S., F.G.S., &c., who was elected into the Society on November 12, 1850.

CHARLES COREY, elected January 27, 1857.

WM. ALEX. MACKINNON, M.A., F.R.S., F.G.S., &c., elected June 15, 1864.

Admiral R. H. MANNERS, late Pres. R.A.S., F.R.M.S., elected June 18, 1862.

JOHN MATTHEW, M. Inst. C.E., F.R.M.S., &c., elected March 11, 1851.

WILLIAM SUMMERBY, elected November 23, 1852.

EDWARD WILLIAM BRAYLEY, F.R.S., was the son of the late Edward Wedlake Brayley, F.S.A., the distinguished antiquary and author of many works on antiquities and topography. Mr. Edward William Brayley was born in London in 1801, and received the rudiments of his education from his excellent mother, of whom he always spoke with warm affection and high esteem. As might be expected, he took great interest in the studies so ardently pursued by his father; but science had attractions for him which he

could not resist. He gave attention to the wide range of physical science, and became a student of Professor Brande's at the Royal Institution. This brought him in contact with Sir Humphry Davy and Mr. Faraday, and led to friendships with them which terminated only at the death of those eminent men. He attended the lectures of Professor Millington, and attracted the attention of that distinguished philosopher, who was indefatigable in aiding his inquiring pupils.

In 1824, when only 23 years of age, we find him to be an active Member of the Meteorological Society, and engaged in its management with Dr. Birkbeck, Mr. Luke Howard, Mr. (afterwards Professor) Daniell, Professor Leslie, and other cultivators of meteorological science. This Society did much to awaken attention to the importance of our science, and to the necessity of having accurately tested instruments in the hands of meteorological observers. On this subject there is a remarkable letter by the late Rev. W. D. Conybeare, M.A., seeking to have instruments made by the same maker, and verified by a comparison with those of the Society, for the Philosophical Institution at Bristol, dated 12th of March, 1824.

Mr. Brayley now became a lecturer on science, and the establishment of Scientific and Mechanics' Institutions in the chief towns of the kingdom, in continuance of the movements begun in London in 1823 by Dr. Birkbeck, opened a large field for the teachers of science. Mr. Brayley availed himself to some extent of the opportunity to gain an income, but continued steadily to pursue his studies. In 1826-27 he delivered lectures on Mr. MacLeay's quinary system of classification of animals, with a view to correct certain misapprehensions of the principles of that classification. These lectures attracted considerable attention amongst naturalists, and placed him on the staff of the 'Zoological Journal.' He was also a contributor to the 'Annals of Philosophy,' and was the author of many papers on Zoology, Geology, and Chemistry in those Journals. In 1831, he was engaged at Hazelwood and Bruce Castle Schools as Professor of the Physical Sciences, in which year he published a modest volume 'On the utility of a Knowledge of Nature,' and styled himself "Lecturer on Natural Philosophy and Natural History."

He had been partially employed for several years at the London Institution prior to 1834, in which year it was determined, amongst other changes, to engage two principal librarians, one to take charge of the department of literature, the other of science; and Richard Thomson, the author of the *Chronicles of London Bridge*, was appointed to the former office, and Mr. Brayley to the latter. The advantages of this change were soon felt in the great improvements which were made in the library. Mr. Brayley was now engaged to lecture at the London Institution, and generally delivered one of the courses of lectures on physical science during the season.

Mr. Brayley was a Fellow of the Linnean Society, a Fellow of the Geological Society, an Associate of the Institution of Civil Engineers, a Fellow of the Chemical Society, a Fellow of the Royal Society, a Fellow of the Astronomical Society, and he was elected a Fellow of the Meteorological Society on the 12th of November, 1850.

His papers on the Physical constitution of the Sun show a profound knowledge of the literature of the subject, and his own views, as gradually developed, are deemed to be worthy of his reputation. He was more a user of observations than an observer, and he was so in meteorology. Meteorites interested him from his youth; and although not a member of the British Association, he was requested to allow himself to be placed on Professor Baden Powell's Committee to report on Meteorites.

His colleague, Richard Thomson, died in January 1865. Mr. Brayley was appointed sole principal librarian, and Professor of Physical Geography and Meteorology in the Institution, so that his duties were much increased. His wife, after an illness of three years, died in May 1869. Mr. Brayley did not manifest his grief; but his friends perceived a great change in him, and on being pressed on the subject, he admitted that he felt occasional faintness. This became more frequent in the autumn. On the 29th of January he was engaged in writing a paper "On the Sun," for the Royal Society, when he became faint several times. He rode home in a cab; on his arrival, he was placed in an easy chair, where he remained, too ill to be moved or even undressed, during the whole of the night and next day. The day after he felt somewhat better, and gave some directions for the sublibrarians, expressing a hope to be at his duties on the morrow. During the night he again became faint, and passed gently away on the morning of the 1st of February, 1870.

WILLIAM ALEXANDER MACKINNON, M.A., F.R.S., F.S.A., F.G.S., &c., of Hyde-Park Place, and Acrise Park, near Folkstone, chief of the clan Mackinnon in the Western Islands; died on Saturday morning, April 30, 1870, at his place, Broadstairs (where he had arrived only the previous day), at upwards of 80 years of age, having been born in 1789. He was educated at Cambridge, where he took his degree of M.A., and afterwards entered Lincoln's Inn as a law student, but was never called to the bar. The late Mr. Mackinnon had for nearly forty years been a Member of the House of Commons, and during that period had been a hard-working and useful member of that assembly. He was elected representative for Dunwich in 1830, and the following year was first elected as representative for Lymington, a borough he continued to represent till 1852, with the exception of the short Parliament of 1838, when he was an unsuccessful candidate. During the time he was in Parliament he brought in bills for the amend-

ment of the patent laws, and to prevent intramural interments in populous cities and towns; he also obtained select committees on the removal of Smithfield Market, and subsequently brought forward measures relative to turnpike-trusts and for establishing a rural police. He was a great friend to animals; and did all he could to protect them from cruelty, having been an active promoter of bills to that effect, and which have long been the law of the land. On his son being unseated, on petition, in 1858 for the Borough of Rye, Mr. Mackinnon was returned for that borough without opposition, and was subsequently re-elected at the elections in 1857 and 1859. At the general election in 1865 he declined coming forward for the borough. Mr. Mackinnon married, in 1812, Emma Mary, only daughter of Mr. B. Palmer, of Palmerstown, County Mayo, and Rushhouse, Dublin, whose large fortune and estates were afterwards inherited by Mr. Mackinnon in right of his wife, who died in November, 1835.

Admiral RUSSELL HENRY MANNERS, F.R.A.S., F.R.M.S., was born in London on the 31st of January, 1800, entered the Royal Naval College the 6th of May, 1813, and embarked March 6th, 1816, as a volunteer on board the 'Minden,' 47, Captain Paterson, in which, after assisting at the bombardment of Algiers, he proceeded to the East Indies, where he served under the flag of Sir Richard King, until nominated midshipman, the 1st of July, 1818, to the 'Orlando,' 36, commanded by Captain John Clavell, with whom, in 1819, he returned to England in the 'Malabar,' 74. After an intermediate employment on the Channel and West-India stations in the 'Spartan' and 'Pyramus' frigates, under Captains William Furlong Wise and Francis Newcombe, he became, on the 29th of July, 1822, acting lieutenant of the 'Tyne,' 26, Captain John Edward Walcot, to which vessel the Admiralty confirmed him the 19th of October following. In May 1823, he rejoined the 'Pyramus,' still commanded by Captain Newcombe, under whom he continued until he obtained his promotion on the 16th of August, 1825. His last appointment was on the 21st of October, 1827, to the command of the 'Britomart,' 10. The 'Britomart' was first employed and intended for the Channel service under the order of the Commander-in-Chief, the Earl of Northesk, at Plymouth. She accompanied the squadron of ships escorting Don Miguel to Lisbon in the early part of 1828. In consequence of the revolution that followed in Portugal on Don Miguel declaring himself absolute, the 'Britomart' was stationed at and off Oporto to watch the British interests there. The Constitutional party, failing to restore the Constitution against the usurped position of Don Miguel, the British Government withdrew her Minister from Lisbon, leaving the British interests in the hands of the Consul only, and Captain Manners was selected to be in readiness to support him in case of need by keeping in sight of signals from Lisbon as long as the safety of the vessel

permitted, but not to anchor within any Portuguese port unless absolutely necessary. This involved a long and vigilant cruising off and on the coast for about eight months, and through the whole of the winter. The only place communicated with during that time was Gibraltar, and then only to receive a supply of provisions and water from the dockyard. The yellow fever unfortunately breaking out at Gibraltar just before going there for this object, no communication could be had with the town, and the stay was confined to from twenty-four to forty-eight hours. The zeal and ability with which this service was carried out by Captain Manners, as witnessed by Sir George Sartorius, there in command of the Portuguese Constitutional Squadron, and under whose orders in some degree the 'Britomart' was placed, led to Captain Manners receiving his Post-rank on the 4th of March, 1829. He retired from active service in March 1849, became Rear-Admiral in July 1855, Vice-Admiral in April 1862, and Admiral in September 1865.

Admiral Manners was the only child of the late Mr. Russell Manners, M.P., and married in 1834 Louisa Jane, daughter of Count de Noé, Peer of France, who survives him, and by whom he has two sons and a daughter.

From the time he attained his Post-rank to the time of his death he devoted himself to scientific pursuits. He was elected a member of the Royal Astronomical Society in 1836. At a very early period he took an active interest in its administration, and after being on the Council for some time, was elected one of the honorary secretaries in February 1848, an office which he filled until 1858, when he accepted that of Foreign Secretary.

He was elected a Fellow of the Meteorological Society on June 18th, 1862.

JOHN MATTHEW, M.I.C.E., was the son of a Russia merchant and was born in London in the year 1820. He was educated at a private school, and, at the customary age, entered, as a pupil, the engineering establishment of Messrs. Penn, of Greenwich. His natural aptitude for mechanical pursuits, finding there a favourable field of exercise, he steadily advanced to high proficiency in the more scientific departments of his profession, and ultimately he became a partner in the firm. In this position the designing and the general superintendence of constructing the great marine engines emanating from this famous manufactory devolved very much upon him; and when we reflect upon the number of these machines and, in some cases, their stupendous proportions, the position in respect of excellence which they hold, the pre-eminence in respect of rapid and economical travelling which they have helped to confer upon the British navy, and the high appreciation in which they have been held in the navies of other countries, we shall find it easier to do justice in thought than in word to the skill and ingenuity—called for in every grand feature of design

and all the minutiae of workmanship—of those immediately concerned with the direction of their manufacture, among whom was the subject of this notice. For his supervisory office Mr. Matthew was eminently fitted: he had a keen perception and a clear mind; and while his character was decisive, his sociability and good-fellowship made him to be liked by all who knew him. As a skilful draughtsman and a dexterous workman, he could in turn instruct the student at the drawing-board, the turner at the lathe, the artificer at the bench, and from each he could educe excellence by example. Handiwork to him was recreation: he had a well-equipped workshop at his private residence, containing, among other tools, a very fine lathe by Holtzapfell, fitted with a geometric chuck, with which it was his delight to execute elegant examples of engine-turning.

Scientific amusements alternated in his leisure with mechanical pursuits. He possessed a varied collection of astronomical, meteorological, and philosophical instruments. At his residence in Greenwich he had a small but good equatorial telescope, mounted in a dome on the house-top; at his country seat at Box Hill, where he resided at intervals for about twelve years before his death, he set up a reflecting telescope; and at his subsequent residence in Park Lane, London, he had a small observatory containing a transit and other instruments. He pursued science, however, rather for the pleasure it gave him in following the doings of others, than with the idea of advancing it by researches or observations of his own; indeed the occupations of his busy life would have left him small opportunity for so doing, if the inclination thereto had existed.

Among other matters calling for allusion in connexion with his leisure occupations, we may mention that he was one of several gentlemen who, upon every convenient occasion, donned the uniform of the metropolitan fire-brigade, and gave assistance to the officers of that service, often making considerable sacrifices of personal comfort for the purpose, and not unfrequently incurring great risk of personal danger. Mr. Matthew had a small museum of objects, more or less curiously damaged by flame and water, which he had recovered from the numerous fires at which he had assisted.

Success, professional and material, attended Mr. Matthew to the measure of his connexion with a successful firm. In the year 1867 he retired from business with fair hopes of healthfully enjoying the fruits of his prosperous labour. In July 1868, however, but one year after his relief from business cares, an illness came upon him that, as months passed on, assumed a serious aspect. His mind gradually weakened and eventually collapsed; and he died on the 7th of August, 1869.

Mr. Matthew was elected a Member of the Institution of Civil Engineers in 1849, of the Royal Microscopical Society in 1850, and of the Meteorological Society in 1851.

WILLIAM SUMMERS was born at Grantham in the year 1816 and was educated at Newark, where he remained until about twenty years of age, being occupied in gaining an insight into the sugar and other trades, previous to succeeding his father in the business of a wine and spirit merchant. Fairly successful in trade, he was liberal with his purse in supporting any scientific object, especially relating to botany, of which he was very fond, but owing to a defective early education (notwithstanding he possessed good abilities), and also by the time taken up by his business, he made no great progress in any branch of science. His public business was also large; for he was a member of the town council of his native place, assessor for the borough, and also a poor-law guardian. Although he had been in an indifferent state of health for some time, his death took place rather suddenly, and he passed away on the 23rd of August, 1869, in the fifty-fourth year of his age.

The following Papers were read at the Ordinary Meetings during the Session 1869-70:—

1. "On the Summer of 1868." By G. Hunsley Fielding, M.D., F.M.S.
2. "To find the Error in Reading the Cistern-Barometer if not hung truly vertical." By Rev. W. Previté, M.A., F.M.S.
3. "November Meteors, 1869."
4. "Account of Two Meteors seen at Bishopsbourne," in a letter to James Glaisher, F.R.S.
5. "Accounts of a Brilliant Meteor seen on November 6, 1869."
6. "On the Temperature and Humidity of the Air at the Heights of 22 feet and 50 feet above the Ground, in comparison with the Temperature and Humidity of the Air at the Height of 4 feet." By James Glaisher, F.R.S.
7. "Rainfall at Jerusalem during the Rainy Season of 1868-69." By Thomas Chaplin, M.D.
8. "Ozone Observations."
9. "On the Influence of the Moon upon the amount of Rain-fall." By John C. Bloxam, M.R.C.S., F.M.S.

10. "The Weather of 1869, as observed at the British Cemetery, Scutari." By Sergt. W. H. Lyne, R.E.
11. "On the recent frequent Appearance of the Auroræ." By James Glaisher, F.R.S.
12. "On the Fall of Rain on every Day of the Year, from observations extending from 1815 to 1869." By James Glaisher, F.R.S.
13. "On the Rainfall in Natal, South Africa." By R. J. Mann, M.D., F.R.A.S., F.M.S., &c.
14. "On some of the Laws which appear to regulate the Temperature of Summer Months and Seasons." By Geo. D. Brumham, F.M.S.
15. "Meteorology of Clifton (Bristol) for the Quarter ending March 31st, 1870." By A. North, F.R.G.S., F.M.S.
16. "Daily Rainfall at Cobham and Chiswick, from 1826 to 1865." By George Dines, F.M.S.
17. "Path of the Large Fireball of November 6, 1869, 11^h 50^m P.M., G. M. T." By Prof. A. S. Herschel, B.A., F.R.A.S.
18. "On the Temperature of the Air in Natal, South Africa, from observations taken at Pietermaritzburg (2095 feet above the level of the sea, and in lat. 29° 36' 13" S.) during the Ten Years 1858-67." By R. J. Mann, M.D., F.R.A.S., F.M.S., &c.
19. "Atmospheric Pressure in relation to Wind and Rain." By R. Strachan, F.M.S.
20. "November Meteors, 1869, in Mauritius." By Charles Meldrum, M.A., F.R.A.S., F.M.S.

Resolved:—

That the Report just read be received and adopted, and that it be printed and circulated among the Fellows of the Society.

Proposed by Alfred North, F.R.G.S.

Seconded by Francis Pastorelli.

The Treasurer's Account for the year 1869.

		<i>Receipts.</i>					
1869.					£	s.	d.
Jan.	1. To Balance of last year						
					27	8	9
April.	Dividend on £1000 New 3 per Cents				14	12	6
Oct.	Do. do. do.				14	13	9
		DIVIDENDS			29	6	3
					£	s.	d.
		Subscriptions for 1866			1	0	0
		Do. for 1867			4	0	0
		Do. for 1868			13	0	0
		Do. for 1869			144	3	0
		Do. for 1870			2	0	0
		SUBSCRIPTIONS			164	3	0
		Rev. S. J. Perry			10	0	0
		John Waterhouse			10	0	0
		Henry Hudson			10	0	0
		COMPOSITIONS			30	0	0
					194	3	0
June 30.	Sales of Proceedings, &c.				8	7	5
Dec. 31.	Do. do.				7	7	8
		SALES			15	15	1
		RECEIPTS			239	4	4
					£266	13	1

1870.
Jan. 1. Balance £37 13 4

The Treasurer's Account for the year 1869.

<i>Expenditure.</i>											
						£	s.	d.	£	s.	d.
1869.											
Jan. 20.	By Proceedings, No. 40	.....				10	18	3			
Feb. 17.	Do. No. 41	.....				13	1	6			
Mar. 17.	Do. No. 42	.....				25	13	6			
April 21.	Do. No. 43	.....				28	17	9			
June 16.	Do. No. 44	.....				39	13	0			
Nov. 18.	Do. No. 45	.....				16	5	6			
PROCEEDINGS, Six Nos.						.....			134	9	6
Dec. 31.	Registrar-General's Reports, 4 quarters	.....							5	12	0
PRINTING						.....			140	1	6
Binding 25 Copies of Vol. IV.						.....			1	2	11
									141	4	5
Stationery						.....			5	19	4
Postage Stamps						.....			6	10	0
Petty Expenses of Secretary and Editor						.....			6	5	6
Attendance, Refreshments, &c.						.....			8	16	6
EXPENSES						.....			27	11	4
Assistant to Editor of Proceedings						.....			52	0	0
Collector's Commission						.....			8	4	0
									60	4	0
PAYMENTS						.....			£228	19	9
BALANCE						.....			37	13	4
									£266	13	1

HENRY PERIGAL, *Treasurer.*W. C. NASH, *Auditor.*

The President having appointed F. Pastorelli and W. C. Nash as Scrutineers, a ballot was then taken, and the following list of Fellows, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the twenty-second Session, 1870-71:—

THE OFFICERS AND COUNCIL

OF

THE METEOROLOGICAL SOCIETY,

ELECTED 15TH OF JUNE, 1870.

President.

CHARLES V. WALKER, F.R.S., F.R.A.S., &c.

Vice-Presidents.

NATHANIEL BEARDMORE, C.E., F.R.A.S., F.R.G.S., F.G.S.

C. O. F. CATOR, M.A.

ROBERT J. MANN, M.D., F.R.A.S., F.R.G.S.

JOHN W. TRIPE, M.D.

Treasurer.

HENRY PERIGAL, F.R.A.S., F.R.M.S., *9 North Crescent, Bedford Square, W.C.*

Trustees.

SIR ANTONIO BRADY, F.G.S., F.R.M.S.

S. W. SILVER.

Secretaries.

CHARLES BROOKE, M.A., F.R.S., F.R.O.S., *16 Fitzroy Square, W.*

JAMES GLAISHER, F.R.S., F.R.A.S., *1 Dartmouth Place, Blackheath, S.E.*

Foreign Secretary.

LIEUT.-COL. ALEXANDER STRANGE, F.R.S., F.R.A.S., F.R.G.S.,
41 Brompton Crescent, S.W.

Council.

A. BREWIN, F.R.A.S.

GEORGE DINES.

F. W. DOGGETT.

HENRY S. EATON, M.A.

FREDERIC GASTER.

CHARLES M. GIBSON.

REV. JOSEPH B. READE, M.A., F.R.S., F.R.A.S., Pres. R.M.S.

W. WILSON SAUNDERS, F.R.S., Treas. L.S.

THOMAS SOPWITH, M.A., F.R.S., F.G.S.

GEORGE J. SYMONS.

SAMUEL C. WHITBREAD, F.R.S., Treas. R.A.S.

E. O. W. WHITEHOUSE, M.R.I.

Resolved:—

That the cordial and best thanks of the Meteorological Society be communicated to the Council of Civil Engineers, for having most liberally granted the Society free permission to hold their Meetings in the rooms of the Institution, during the Session that has just ended.

Proposed by Dr. Tripe.

Seconded by C. M. Gibson.

That the best thanks of the Society be given to Charles V. Walker, F.R.S., for his services as President during the past year.

Proposed by Dr. Tripe.

Seconded by S. W. Silver.

NOTICE.**SESSION 1870-71.**

The Meetings will be held on the Third Wednesday in the months,
at 25 GREAT GEORGE STREET, WESTMINSTER, S.W.,
by the kind permission of

THE COUNCIL OF THE INSTITUTION OF CIVIL ENGINEERS.

COUNCIL MEETINGS at 6 P.M.

1870. October	19	1871. March	15
„ November	16	„ April	19
1871. January	18	„ June	21
„ February	15	„ October	18

ORDINARY MEETINGS at 7 P.M.

1870. November	16	1871. March	15
1871. January	18	„ April	19
„ February	15	„ June	21

The Annual General Meeting will be held after the Ordinary Meeting on June 21.

PROCEEDINGS OF THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1870, NOVEMBER 16.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
XXI. On Respiration and Evaporation-gauges, with some Remarks upon the Formation of Dew.—George Dines, F.R.S.	189
XXII. On a Storm at Calcutta, followed by a remarkably Hot and Dry Wind.—Lieut.-Col. J. F. Tennant, R.E., F.R.S., F.M.S.	210
XXIII. The Aurora Borealis of September 19th, and October 25th, 1870	230

Correspondence, &c.:—

Letters from Commander Edmund H. Verney, F.M.S., Surgeon-Lieut. G. L. Tappan, R.M.A., F.M.S., and Thomas Supwell, M.A., F.R.S., F.M.S.	237
--	-----

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.
Published 1871, January.

ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line..	0	0	6	Bills, half-sheet and less..	1	10	0
Half a page	0	17	6	„ whole sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

SESSION 1870-71,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1870. November	16	1871. March	15
1871. January	18	„ April	19
„ February	15	„ June (ANNUAL)	21

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Hours of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

"Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. BELVILLE'S Books."—*Athenæum*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1870, NOVEMBER 16. [No. 51.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Gilbert, Joseph Henry, Ph.D., F.R.S., V.-P.C.S., *Harpenden, St. Albans* ;
Marten, Charles Rous, Director of Meteorological Stations, *Southland, New Zealand* ;
Sawyer, Frederick Ernest, 55 *Buckingham Place, Brighton, Sussex* ;
Wilson, Thomas Henry, *Adelaide Road, London, N.W.* ;
were balloted for and duly elected Fellows of the Society.

The name of One Candidate for admission into the Society was read.

XXI. *On Evaporation and Evaporation-gauges, with some Remarks upon the Formation of Dew.* By GEORGE DINES, F.M.S.

ALTHOUGH the broad and general principles on which evaporation depends were clearly laid down by Dr. Dalton nearly seventy years ago, yet up to the present time the quantity of evaporation from a large body of water has not been satisfactorily determined in this, or, as far as I know, in any other country, since the best

observers of the present day vary greatly in their estimate of the yearly amount. This must be my apology, if any be necessary, for bringing this paper before the Society. It does not pretend to give the true quantity, but only to point out the causes of such differences, the faulty construction of many of the present evaporation-gauges, and also to lay down the conditions which must be observed before the true amount can be determined.

As far back as the year 1842 I made many experiments upon evaporation; but these had reference to the best construction for drying-closets, and not to meteorological purposes. The subject remained without my paying any particular attention to it, until, from some remarks made by Mr. Symons in his 'British Rainfall for 1868,' my attention was again drawn to it; and during the greater part of the year 1869 I had several evaporation-gauges at work; the results given by these were so discordant and so utterly inconsistent with each other, and the annoyance and trouble I have experienced in my business from condensation upon the surface of walls and glass have been so great, that I determined more thoroughly to investigate the subject. For some of the experiments made with this purpose, a balance capable of weighing with extreme accuracy was used; the method adopted was as follows:—

In one of the scales was placed a vessel containing water, the weight of which, owing to condensation or evaporation, is continually changing; a thermometer was suspended from the end of the beam, with the bulb just immersed in the water; weights were then placed in the other scale, and the time at which they balanced each other taken. A small weight, generally one grain (but sometimes as small as $\frac{1}{10}$ of a grain), was then taken from, or added to the scale, and the time at which the scales again balanced noted down. For convenience of calculation, the vessel containing the water was made about $2\frac{1}{4}$ inches in diameter, so that one grain in weight was equal to the $\frac{1}{1000}$ part of an inch in depth of water; to determine the temperature of the dew-point, dry- and wet-bulb thermometers were placed in close proximity, and read occasionally as required. The experiments were sometimes made with water of the ordinary temperature, at others with hot water, and also with water artificially cooled. The Tables which follow are a specimen of each, and will best explain the plan adopted, and the results given.

TABLE I.

Time.	1. Dry-bulb Thermo- meter.	2. Wet-bulb Thermo- meter.	3. Calcula- ted Dew- point.	4. Tempera- ture of Water.	5. Loss of Weight by Evapo- ration.	6. Rate of Evapora- tion per Hour = E.	7. Value of x in the formula Ds = E.
h m s	°	°	°	°		in.	
6 54 12	60.7	52.4	45.2	95.4	1 grain	.0210	.0166
6 57 3	61.0	52.7	45.5	91.2	1 "	.0165	.0156
7 0 42	61.1	53.0	45.9	86.6	1 "	.0126	.0145
7 5 28	61.2	53.2	46.2	82.0	1 "	.00994	.0142
7 11 30	61.5	53.3	46.3	77.3	1 "	.0072	.0129
7 19 50	61.8	53.6	46.5	73.0	1 "	.00558	.0125
7 30 35	62.1	53.8	46.6	69.1	1 "	.00428	.0120
7 44 35	62.1	54.0	47.0	66.2	1 "	.0036	.0122
8 1 15	62.2	54.4	47.7	64.3	1 "	.00308	.0118
8 20 45	62.5	54.7	48.0	63.5	1 "	.00301	.0124
8 40 40	62.8	55.0	48.4	62.8	1 "	.00274	.0120
9 2 35	62.8	55.2	48.7	62.6	1 "	.00264	.0119
9 25 20	62.7	55.3	49.0	62.6	1 "		

TABLE II.

Time.	1. Dry-bulb Thermo- meter.	2. Wet-bulb Thermo- meter.	3. Calcula- ted Dew- point.	4. Tempera- ture of Water.	5. Increase of Weight by Con- densation	6. Rate of Evapora- tion per Hour = E.	7. Value of x in the formula Ds = E.
h m s	°	°	°	°		in.	
7 17 15	56.0	51.4	47.1	33.7	0.1 gr.	-.00252	.0178
7 19 45	56.4	52.0	47.9	33.8	0.2 "		
7 24 20	57.0	52.6	48.6	34.3	0.2 "		
7 29 10	57.2	53.0	49.1	34.8		-.00237	.0168
7 29 10	57.2	53.0	49.1	34.8	0.1 "		
7 31 25	57.4	53.0	49.0	34.9	0.2 "		
7 36 10	57.7	53.0	48.8	35.2	0.2 "		
7 41 50	58.0	53.1	48.7	35.8		-.00228	.0174
7 41 50	58.0	53.1	48.7	35.8	0.1 "		
7 44 15	58.1	53.1	48.6	35.9	0.1 "		
7 47 5	58.3	53.2	48.6	36.1	0.2 "		
7 52 20	58.5	53.4	48.8	36.8		-.00169	.0137
7 52 20	58.5	53.4	48.8	36.8	0.1 "		
7 55 50	58.7	53.7	49.2	37.7	0.1 "		
7 59 25	59.0	53.8	49.2	38.6			

After this time a weight equal to 0.28 grain was added to the weight scale; at 8^h 14^m condensation ceased with the thermometer at 44°; at 8^h 16^m, with the thermometer at 45°, evaporation commenced; and 0.4 of a grain had evaporated by 8^h 27^m 25^s, the thermometer reading 49° 8.

The five columns on the left hand of the Tables require no explanation; the 6th column gives the rate of evaporation per hour in inches: for instance, taking the first two lines, the amount of evaporation was one grain, or the $\frac{1}{1000}$ part of an inch in 2 minutes 51 seconds, equal to $\cdot 021$ in. per hour. The 7th column has been introduced for comparing the results given by the different experiments, and is in agreement with Dalton's rule for determining the amount of evaporation: here D is equal to the pressure of vapour (in inches of mercury) at the temperature of the water, less that at the temperature of the dew-point; for instance, the pressure of vapour at the mean of $95^{\circ}4$ and $91^{\circ}2$ is $1\cdot565$ in. The pressure at $45^{\circ}3$, the mean temperature of the dew-point, $=\cdot303$, the difference $=1\cdot262$ in.; this, multiplied by $\cdot0166$, or the value of x , gives $E=\cdot021$, or the amount of evaporation per hour, as shown in the preceding column. I may add that the pressure of vapour, and the numbers necessary to determine the temperatures of the dew-point, have been taken from Glaisher's Tables, 4th edition; but where the temperature has exceeded 100° , Dalton's Table has been used.

In Table II. the experiment was made with water artificially cooled; in this case the tension of vapour at the temperature of the dew-point was the greater, and therefore the value of D was negative; the amount of evaporation per hour, as given in the Table, is also negative; this shows that, instead of evaporation, condensation upon the surface of the water took place; this continued until the temperature of the water was nearly equal to that of the dew-point; the balance then remained almost stationary for a minute or two, when evaporation commenced. This experiment, with others of the same description, opens up a most interesting question connected with the formation of dew; and it will be seen that the value of x in both Tables is nearly the same. I should have much liked to have pursued this part of the investigation further; but I have been obliged to content myself with a few experiments. By sliding pieces of tinfoil down the stem of the thermometer, the surface of the water was covered with them; the condensation upon the tinfoil appeared to be the same in amount as that upon the water; and the evaporation commenced also at the same temperature. Mr. Glaisher, writing upon this subject in the year 1847, says:—"The formation of dew was found to depend solely on the temperature of the bodies upon which it is deposited; and it never appeared upon them till their temperature had descended below that of the dew-

point in their locality, as found by observations of a dry- and wet-bulb thermometer placed in their vicinity." All my experiments agree with this; but I wish to add that the amount of dew appears to be proportional to the difference between the pressure of vapour at the temperature of the body upon which it is deposited and that of the dew-point. In ordinary cases dew is rarely deposited upon the surface of water; and I have never noticed it upon the outsides or edges of my larger evaporation-gauges, although the wirework by which they were protected from the birds has been covered with dew-drops.

I shall have to refer to these Tables again, and will therefore now only say that they were not conclusive to my mind; I therefore determined to make some experiments upon a much larger scale; but, the balance in this case being inapplicable, the great difficulty was how to measure so small a depth of water as the $\frac{1}{1000}$ part of an inch. After many trials (some made with a vertical float and a vernier attached), the following plan was adopted. In a small covered vessel communicating with a larger evaporating gauge by a short pipe the measuring-apparatus was placed; this will be best understood by the drawing on p. 212. A is a float fixed on a centre at the bottom of the vessel; as the water lowers by evaporation, the float falls over, and the quantity is measured upon the circular arc B. A float, fixed in this manner, works almost without friction; and it has this advantage, that it may be made of sufficient length to ensure a good open scale; if the divisions on the arc are made equal, a table of corrections is required. After eighteen months' trial, I have every reason to believe that its indications may be depended upon, although not to the extreme accuracy of the balance. With this means of measurement, and in one of my evaporation-gauges 18 inches in diameter, 6 inches in depth, buried in earth nearly to the upper edge in the hollow stump of a large elm-tree, the following experiments were made. The vessel was filled with hot water, the temperature of which was taken every minute, in order to get at the mean pressure. Calculating in the same way as in Tables I. and II., and, allowing for the dew-point pressure, the following results were obtained:—

Temperature of Water.	Rate of Evapo- ration per Hour. in.	Value of x .
170 $\frac{1}{2}$ to 158 $\frac{0}{0}$	0·420	·0446
153 to 139	0·295	·0452
139 to 118	0·173	·0435

Another experiment.

Temperature of Water.	Rate of Evaporation per Hour. in.	Value of x .
$176\frac{1}{2}$ to $154\frac{1}{2}$	0·431	·0454
$153\frac{1}{2}$ to 138	0·285	·0462
138 to 126	0·187	·0441

Other experiments, made in a closed room with a vessel 8 inches in diameter, 6 inches deep, gave as follows, the vessel being suspended over a gas-jet, by which means the water was kept at nearly the same temperature for any length of time.

Temperature of Water.	Rate of Evaporation per Hour. in.	Value of x .
166 to 163	0·246	·0247
139 to 135	0·111	·0232
$112\frac{1}{2}$ to 111	0·0515	·0287
$108\frac{1}{2}$ to 102	0·0361	·0232

Another experiment.

161 to 156	0·205	·0232
$130\frac{1}{2}$ to $129\frac{1}{2}$	0·0885	·0225
$100\frac{1}{2}$ to $99\frac{1}{2}$	0·0322	·0219

It must here be stated that no great importance is attached to the value of x , except as a means of comparison *during the continuance of one experiment*; its value appears to vary with the slightest alteration in the movement of the air; and some of my earlier experiments were rendered doubtful by not attending to this point. On one occasion a door communicating with another room was kept alternately open and closed; this caused a difference in the value of x , or, in other words, in the amount of evaporation, amounting to twenty-four per cent. On some occasions the value of x , in doors, has been as low as ·0118; out of doors, in by no means a strong wind, as high as ·0742. The calculations from fifty-one experiments made out of doors gives the mean value of x ·0487; the values in the three columns of Dr. Dalton's table are respectively ·0336, ·0432, and ·0538. At present I see no better method than this of comparing the amount of evaporation at different temperatures; it appears to answer very well when the amount of evaporation is considerable, and

the experiment continues for a short time ; but when the temperature of the water and that of the dew-point are within a few degrees of each other, with a sluggish evaporation, the least error in the measurement becomes of importance, and, to get any thing like correct quantities, the experiments must be continued for some length of time. In this case, owing to the uncertain movements of the air, I have never felt any confidence in comparing the experiments of one day with those of another. The slightest difference in position also appears to affect the amount of evaporation ; in some of my experiments, where water has been placed in both scales, it has always been considered necessary occasionally to reverse the position of the vessels, in order that the difference in the currents of air passing over the two scales might not affect the results. If any one should feel disposed to repeat these experiments, it is recommended that they be made in the centre of a large room, with the doors and windows closed, in order to be as free from atmospheric changes as possible. Before commencing these experiments, I had thought the amount of evaporation might be obtained by calculation from the dry- and wet-bulb thermometers ; but I should now place little reliance upon any deductions arrived at by such means.

There are several sources of error to which the experiments in pages 203 and 204 are liable—from the thermometers at so high temperature, from the difficulty of obtaining the true temperature of hot water, from the use of two sets of tables, from the tables themselves, and, above all, from the movement of the air ; when these are taken into consideration, the near approach to equality in the values of x , while the rate of evaporation per hour has been as 6 to 1, proves almost to demonstration the truth of Dalton's law ; yet, on referring to Table I., it will be seen that the value of x , instead of being equal, steadily decreases with the temperature of the water. In nine experiments of this class, made with the balance, all gave similar results : these have been to me a source of great perplexity. At first I thought that the bulb of the thermometer, being covered and buried as it were in the water, did not give the true temperature of the surface from which the evaporation takes place ; but the most sensitive thermometer, with an elongated bulb in no part exceeding $\frac{1}{10}$ of an inch in diameter, supplied to me by Mr. Casella for this special purpose, failed to show any material error from this source ; and I have been driven to the conclusion that it arises from the

following cause—namely, that the temperature of the water, differing considerably from the temperature of the air, causes an increased circulation of air to take place over the surface of the water; and this, as I have before noticed, would greatly increase the evaporation.

In Table No. II. another difficulty occurs: the evaporation appears to commence when the temperature of the water is below that of the dew-point. Eight experiments of this description all gave the same results, the evaporation commencing at a time when the temperature of the water, as shown by the thermometer, was from 3° to 4° below the calculated dew-point. This is so contrary to the principles on which the hygrometer is founded, that I cannot but consider it an error arising from some of the sources before named, which I am at present unable to determine*. The experiments, of which Tables I. and II. are specimens, were generally made in a closed room, partly by gas-light, and in a rather dry atmosphere: my wish has been to repeat the experiments in a saturated air, by which some of the sources of error named would have been avoided; but no opportunity of doing so has occurred†.

Notwithstanding these discrepancies, the experiments I have here given, when taken altogether, clearly point to the following conclusions. Commencing with water at 176° , and working downwards, the evaporation, although decreasing in quantity, continues until the temperature of the water passes below that of the air and approaches that of the dew-point. Again, commencing with water at 32° , and working upwards, condensation continues until

* [The temperature of the exterior film was probably different from that of the mass of the water. The neighbouring air heats the surface, and evaporation takes place when the heated film is so thin that no thermometer would detect the difference of its temperature from that of the water below. The conductivity of water is very small, and the mass of the water in the gauge is ultimately heated by convection from the sides and bottom. If the temperature were below 39° (as in the case of Table II.) the point of maximum density for water, the layer on the surface would descend as soon as it was heated, and no evaporation could take place; in fact, as the colder strata would continually rise to the surface, we should naturally expect corresponding condensations. Considerations of a similar character apply to the results in Table I.; the variation of x is a simple consequence of the more or less rapid change of surface-water.—Ed.]

† Some experiments made December 12th, 1870, in a small greenhouse, the air of which was nearly saturated with moisture, show clearly that condensation continues upon the surface of water until its temperature reaches that of the dew-point; condensation then ceases, and evaporation begins.

the temperature of the water approaches the same point; the line of demarcation where condensation ends and evaporation begins, must therefore be at or very near to the dew-point temperature. And although the formula I have used cannot, for the reasons stated, be applied with any certainty when the temperature of the water and that of the dew-point approach near to each other, yet it must be admitted that at both extremes it gives a good approximation; and I shall therefore for the purposes of this paper assume the two following propositions to be correct:—

1. That no evaporation takes place from water unless the temperature of the water is greater than that of the dew-point.

2. That the amount of evaporation from water is proportional to the difference of the pressures of vapour at the temperature of the water and at the temperature of the dew-point.

I shall now describe some of the evaporation-gauges used; three of these will be sufficient. No. 1 has been already noticed (see p. 203); No. 2 is 8 inches in diameter, and 6 inches deep; No. 3 is 5 inches in diameter, and 3 inches deep.

Nos. 2 and 3 were placed near No. 1, the sides exposed to the atmosphere. Discarding all days when the quantities given might have been affected by the rainfall not being collected equally, the evaporation in April and May, 1870, during twenty-one days was as follows:—

	in.	
From No. 1 gauge	2·887, say equal 100	
" 2 "	4·168	" 144
" 3 "	5·017	" 174

It will at once be seen by the figures given, that the amount of evaporation from No. 3 gauge is 74 per cent. in excess of that from No. 1; and the question at once arises, What is the cause of this great difference? The answer is, the water in the smaller gauge is more heated by the rays of the sun than that in the larger one*; and as the temperature of the dew-point is the same, the evaporation from the smaller gauge must be the greatest.

* [The greater temperature of the water in the smaller gauge is not only due to the greater time required to heat a larger amount of water by conduction, but also to the effect of the sides of the gauge. These having a much smaller specific heat than water, rise rapidly in temperature relatively to the latter; and as the surface exposed to the water varies as the square of the linear dimensions of the gauge, while the mass of the water varies as the cube, the relative effects vary inversely as the size of the gauges.—ED.]

Where evaporation-gauges of one pattern have been in use for years, they may be of some service for the purposes of comparison, although not likely to give the correct quantity; but, as a rule, each maker has his own pattern, and they have been made of all sorts and sizes, and very rarely, under the same circumstances, would the temperature of water, when placed in the sun, be the same in one gauge as in the other. Principally from this cause the labours of myself and others have been rendered scarcely worth the paper upon which they are written. I must, for this reason, make this point perfectly clear, and beyond the possibility of dispute.

During the summer months I have at the same time frequently noticed a difference of 10° in the temperature of the water of different gauges, and at times the outsides of the smaller gauges have been almost too hot to touch. On looking over my journal I find that on many days the evaporation from the smaller gauges has been nearly double that from the larger ones, and on eleven days it has exceeded that proportion. Now assuming, for example, that the temperature in the shade is 78° , the dew-point 56° (not a bad proportion for a summer's day), that the water in one gauge is 70° , in another 80° , what, by calculation, would be the difference in the amount of evaporation? The pressure of vapour at the temperature of $70^{\circ} = .788$ in.; at 56° , the dew-point, $= .449$ in.; the difference is $.284$. The pressure of vapour at 80° (the temperature of the water in the other gauge) $= 1.023$ in., at the dew-point as before $= .449$ in.; the difference $= .574$. Now the numbers $.284$ and $.574$ represent the proportionate amount of evaporation; and one is more than double that of the other.

What follows will probably be considered more satisfactory than any calculations that may be made. During part of the months of June and July last, gauges No. 2 and No 8. were placed in and surrounded by the water of gauge No. 1, the water and means of measurement being kept perfectly distinct; the temperature of the water in the three gauges was often tried and found to be nearly the same at the same time. What are the results? Discarding, as before, all rainy days, the evaporation in twenty-nine days was as follows:—

	in.	
From No. 1 gauge	5.510, say equal 100	
" 2 "	5.908	" 107
" 3 "	5.617	" 102

By this simple arrangement gauges Nos. 1 and 3, which, under other circumstances, differed 74 per cent., have been brought to agree within 2 per cent. What is here stated will, it is hoped, be sufficient to show that all evaporation-gauges, to be worthy of the name, must by some means or other be so constructed as to maintain the water placed in them at the same temperature as that of the large body of water from which the quantity of evaporation is required. Another circumstance connected with this part of the subject may be noticed: with scarcely an exception, the evaporation from the smaller gauges during the day is greater than that from the larger. During the night the contrary is the case; the evaporation from the larger gauge is greater than that from the smaller. The explanation of this is easy: the smaller quantity of water rapidly cools down towards the evening, while the larger retains longer into the night part of the heat it has acquired during the day; and as the temperature of the larger body is therefore greater than that of the smaller, while the dew-point is the same, the evaporation from the larger gauge must be greater than that from the smaller one.

As to the size of the gauge, there can be no doubt that the evaporation is in proportion to the surface of water; but, at the same time, a greater amount takes place from the smaller gauges. I have no direct experiments bearing upon this point; but the excess in the smaller gauges appears to be caused by the following circumstance, namely:—owing to capillary attraction, and the ripple upon the water caused by the wind, the inside of the vessel above the water-line is always more or less wet, say for one-fifth of an inch in height. This materially alters the surface from which evaporation takes place. The smaller the gauge, the greater the proportionate increase: No. 1 gauge contains 254 square inches of water-surface; the increase from the cause named is 11.3 in., or about $4\frac{1}{2}$ per cent., while No. 3 gauge, which contains 19.6 inches, is increased 3.14 inches, or 16 per cent. In order, therefore, to avoid this source of error, the gauge should be made as large as possible. I have little doubt the excess of evaporation from No. 2 gauge, as shown on p. 208, was owing to this cause, as the capillary attraction in that gauge appeared to be greater than in Nos. 1 and 3.

The depth at which the water is kept below the edge of the gauge has also a great influence upon the amount evaporated. My first experiment was made by placing the Nos. 2 and 3 gauges

in the water of No. 1; the water in No. 1, as it evaporated, was constantly renewed; that in No. 2 and 3 was allowed gradually to evaporate without being filled up. At the end of ten days the amount evaporated was as follows:—from No. 1, 1·902 in.; from No. 2, 1·804 in.; from No. 3, 1·665 in.: the errors arising from this cause being greater than was expected, other experiments were made. Two vessels, 8 inches in diameter, called Nos. 4 and 5, were placed side by side on the inside of a window-board: at first both were kept full of water; but, owing probably to the different set of the currents of air, they seldom read alike; sometimes one, sometimes the other was in excess; but at the end of eleven days the total evaporation was:—from No. 4, 1·13 in.; from No. 5, 1·17, in., or 4 per cent. in excess of No. 4. The water was then lowered in No. 5, No. 4 being always kept full. With the water in No. 5 at 2 inches below the edge, the evaporation was, from No. 4, 0·97 in.; from No. 5, 0·79 in., or 18 per cent. less. At 3 inches below, from No. 4, 0·67 in.; from No. 5, 0·434 in., or 35 per cent. less. At 4 inches below, from No. 4, 0·62 in.; from No. 5, 0·414 in., or 33 per cent. less. These experiments, although the results given are rather irregular, show in the most unmistakable manner the serious errors likely to arise from this cause; and, in order to diminish this source of error (as well as the one before named), the evaporation-gauge should be made as large as possible, and be kept nearly full of water.

I have throughout this paper carefully avoided giving an opinion as to the amount of evaporation yearly, or any figures by which it might be arrived at, for the simple reason that I have no data that can be depended upon; except by a balance of errors quite unlikely to take place, not one of my gauges would give the correct amount; the variation in the temperature of the water is too great even in my largest gauge (No. 1). A maximum and a minimum thermometer is kept in this gauge, and also in the river Mole close by. During the present summer they have varied as follows:—

April	32° to 77° in the gauge	39° to 60° in the river.
May	32 to 84 „	46 to 69 „
June	46 to 92 „	56 to 69 „
July	48 to 89 „	56½ to 71½ „
August	44 to 84 „	56 to 66 „
September ...	43 to 74 „	51½ to 60 „
October	32 to 69 „	45½ to 59 „

I am not aware of the variation which takes place in the temperature of the sea, or of a larger river than the Mole, but expect it would be much less than is here given.

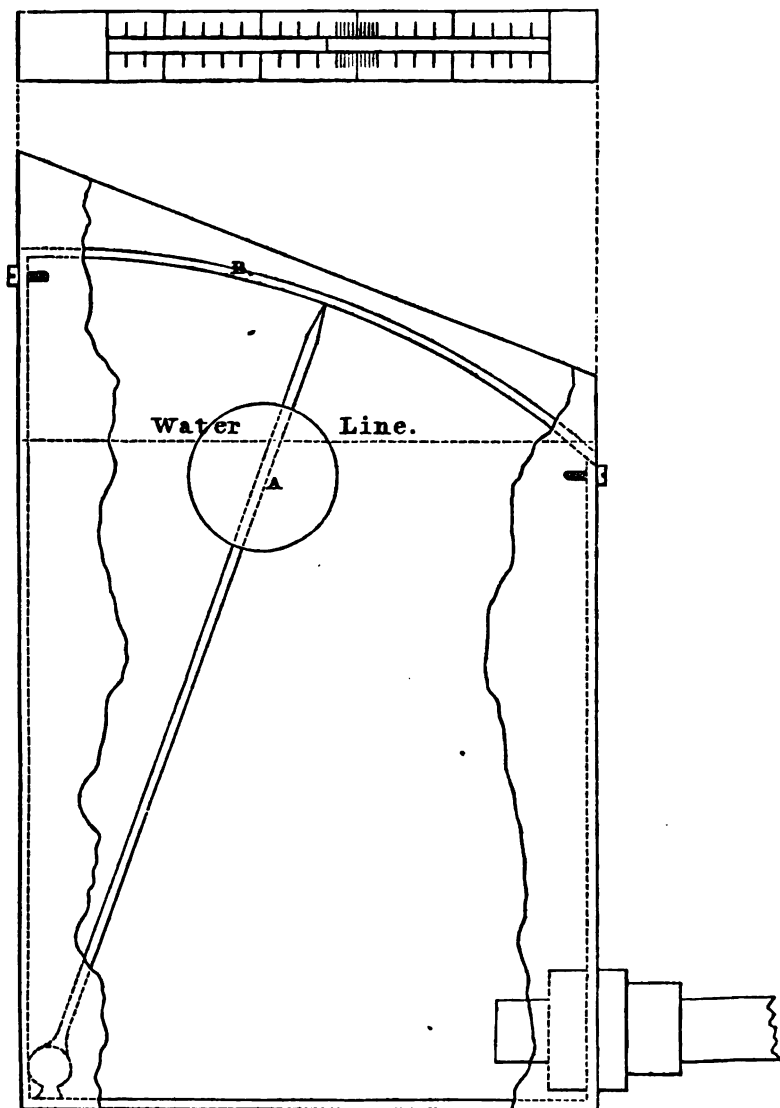
Before leaving this part of the subject, I will briefly state how, in my opinion, an evaporation-gauge might be fixed. If placed in a large piece of water, most of the conditions required could be met, but, if required to be read often, it would be found extremely inconvenient; for this reason I should much prefer the following method:—At any open place where a fall of water could be obtained, such, for instance, as a mill-pond or canal-lock, let a moderate-sized cistern with an overflow-pipe be fixed; in this cistern place the evaporation-gauge; a pipe led from the upper level of water into the cistern would keep up a circulation of water outside the gauge, and maintain the water placed in it at the same temperature as that of the larger body. The top of the cistern could be fixed at a convenient height from the ground, so that the gauge could be easily read: and I need scarcely add that a rain-gauge must be fixed close by at the same height.

Some experiments, made with grass closely cut, show that when thoroughly saturated the evaporation from it is greater than from water; but this state of things does not long continue, and the evaporation from grass soon becomes less than that from water; the same remarks also apply to garden mould; and, as no particular point of saturation could be defined, these experiments were not continued; but the amount of evaporation from the land (except for a short time after rain or heavy dew) is no doubt much less than from water.

The evaporation from sea-water, taking the average of several experiments, gave $4\frac{1}{2}$ per cent. less than from rain-water: but if the sea-water was allowed to stand for a time and so become saltier, or if water saturated with salt was tried, the difference became greater, in one instance amounting to 15 per cent.

No opportunity has yet occurred to me of trying the evaporation from snow or ice; but this is no doubt considerable, as in frosty weather the air is frequently very dry, and the dew-point much below 32° , while the snow and ice often remain nearly at that temperature, and under these circumstances a large amount of evaporation would be going on. With the break-up of a frost all is changed: the air is generally saturated, and the dew-point over 32° . While the frost-bound earth, with its partial covering of snow and ice, remains for some time at that temperature, con-

PLAN.



densation will take place upon its surface ; and the moist and sloppy nature of the ground when a thaw sets in is partly owing to this circumstance*.

In conclusion, I will briefly state my opinion as to the various causes upon which, *separately and combined*, evaporation depends.

First and greatest is the movement of the air ; this varies so much that the evaporation would in some cases be seven times as great as in others.

Secondly. Whatever tends to increase the temperature of the water, increases the evaporation ; and any thing which lessens the temperature of the water lessens the evaporation.

Thirdly. Whatever tends to increase the temperature of the dew-point lessens the evaporation ; and any thing which lessens the temperature of the dew-point increases the evaporation.

With these ever-changing circumstances, the ebbs and flows which take place in the amount of evaporation during the twenty-four hours of the day must be something considerable. To me this appears to be the most interesting part of the investigation ; and I much regret that I have neither the time nor the opportunity to carry it out : to those who have, and are interested in such questions, I feel assured that the trouble they took would be amply repaid ; for I cannot conceal from myself that, if the principles laid down in this paper are correct, unexpected results must follow—such, for instance, that the evaporation would often be found less in sunshine than in shade, and greater by night than by day ; but it must be understood that I am speaking of the evaporation which takes place from large bodies of water, the daily change in the temperature of which is small, and not from that of a few inches, cooped up in narrow vessels, which might with some truth be called, not evaporating-gauges, but evaporators.

XXII. *On a Storm at Calcutta, followed by a remarkably Hot and Dry Wind.* By Lieut.-Col. J. F. TENNANT, R.E., F.R.S., F.M.S.

THE storm concerning which I am going to offer a few notes took place on the evening of Friday, May 20, 1870. It was one of a class common in Calcutta during the hot, dry season, but had

* On December 27, 1870, with the temperature varying from 28° to 29°, the evaporation from the surface of snow was equal to 0·0061 inch of water in four hours.

some remarkable accompaniments. Generally these storms blow from the north-west, and are accompanied by a good deal of rain; they do not last long; and, once past, the wind rarely rises again. The first visible sign of one is a bank of clouds in the horizon, which rises slowly, and is bounded by a circular arc with some accuracy. The bank becomes blacker, and lightning is seen; then the clouds rise rapidly, and overspread the sky, accompanied by violent wind and rain. The usual result is a pleasant coolness, a reduction of the temperature, and increase of the humidity.

On the present occasion Calcutta had long been without rain; but, for a few days previous to that of this storm, the air had been sensibly damper and cooler, till, on the evening of the 19th, there came a heavy storm of wind of the usual type, but without much rain. On the 20th I was out with a friend, and was struck with the blackness of the sky to the south-west. No long time passed before the usual circular space was almost black with rain-clouds. These rapidly rose, and the darkness became very great. The heaviest clouds formed a species of border to a lighter space. Outwardly the circular arc was not at first so much disturbed; but the inner edge of the ring was extremely ragged, portions of the clouds descending, as often in thunder-storms, far below the general level. There was a little lightning. Of course we hurried home as fast as we could, and for the greater part of the distance we had our backs to the storm; but the wind rose rapidly, and drifted the rain almost horizontally; and it seemed to veer round more towards the usual quarter for these storms, so that, by the time we reached home, the heaviest gusts were coming from the north of west. Gradually the storm decreased in violence, till about 8 P.M., when it seemed to begin afresh. Shortly after 9 it moderated, and the rain continued to fall lightly. About 10 P.M., however, while rain was yet falling, came a sudden hot and dry blast of air, which was followed very shortly by a second; and then the wind became warm and dry, though more moderate. I was told by a friend who looked at a thermometer, that he saw it rise 15° Fahr. in a few minutes; and by a note in the papers I see that, at St. Xavier's College, an attempt to take the temperature gave it as 93° Fahr.; but, from the short time the hot blasts lasted, this could not have been the full heat. I can only compare what I felt to the wind from a great fire or furnace. The heat lasted some time, the rain ceasing; and the storm was renewed about midnight. On Saturday and Sunday evenings we have had similar storms,

each, as usual, coming somewhat later than that of the previous day.

The winds seem to have oscillated from west to north-west, but I was completely sheltered from all the heaviest gusts after my return home by a wall running almost due east and west. The greatest pressure seems to have been about 38 lbs. on the square foot.

I have constantly noticed that these storms are prognosticated, not so much by a fall of the barometer below its normal height, as by a remarkable flatness of the surface of the mercury. When formerly in Calcutta, I had only an aneroid for reference, and was much puzzled by these violent gales coming with so little warning; but, having now convenient access to a standard by Newman, I have never been deceived by this sign. A reference to the plot annexed of the day barometric curve will show that the reading of the barometer at 5 P.M. is only 0.03 in. below that at 3 A.M., and 0.157 in. below that at 9 A.M.; and these are about the usual amounts. It seems to have hung at the lowest reading instead of rising as usual, and then to have jumped up 0.122 in. between 6^h and 6^h 50^m P.M., falling again afterwards. Except a slight wave about 9 P.M., I have never seen this happen except at the end of a storm, when, however, I have seen a similar rise in little more than ten minutes on one occasion, such a rise being accompanied by the restoration of convexity to the mercurial surface.

It will be seen, from the curve of difference of dry and wet thermometers, that from 6 A.M., when the difference was only 2°.7 Fahr., the dryness increased till 3 P.M., when it was 11°.2 Fahr.; it then decreased till 7 P.M. (when the storm began), when the difference was 5° Fahr.; this difference, during all the wind and rain, rose till it became 18°.3 Fahr. at 10 P.M., when the hot gust came on. I have received ten-minutely readings of the barometer and thermometer from 6^h 50^m till 9 P.M., but do not send them. I have extracted the sudden rise of the barometer, which is the only material fact. The exposure of the thermometers makes them quite useless except for humidity.

XXIII. *The Aurora Borealis of September 24th, 1870.*

B. W. SMITH, F.R.A.S., F.M.S.

AMONG the many exhibitions of aurora with which we have been favoured during the last few weeks, that of September 24 was in some respects the most remarkable; and as no account that I have seen gives at all an adequate description of it, I venture to send you a few rough notes. I may say that I had unusual advantages in watching it, as I happened to be driving among the Welsh hills between Corwen and Conway during the greater part of the night.

The 24th was a hot day, and almost cloudless, and the sun set, just before 6^h, behind a low bank of cirrocumulus, which lit up gorgeously for a time. By 7^h it was dark, and there was then no aurora. About 7^h 30^m a faint red flush appeared to the west of north, changing to a steady glow of the usual yellowish white, which then increased steadily in extent and brightness. At 8^h it was much brighter, the bank of cloud forming a dark base, and concealing its lower limit. There were then no streamers, and no variety of colour.

At 8^h 30^m it was still brighter, and streamers appeared with well-defined edges. To north-east especially the dark intervals were very marked, and from this time the change and motion of the streamers became noticeable. The centre of greatest energy seemed to be direct north, and at about 8^h 45^m a ray shot up over and beyond the pole-star, of four or five times the intensity of the general glow, and resembling a good deal some of the old pictures of the Israelites' Pillar of Fire. At this time it was almost light enough to read. I had no print of any kind with me, but could make out many words of a written letter. There was no red colour except in the extreme west ray.

About this time a long band of light with sharp parallel edges appeared overhead, proceeding in a south-east direction from the Milky Way, and gradually drifted thence to the south, preserving its form and remaining visible for nearly an hour.

About 9^h appeared a sort of waving motion, like wreaths of luminous smoke, but perfectly transparent to the stars, rising from the main body of light, and passing up to beyond the zenith, and increasing in intensity and rapidity of motion till the whole northern half of the sky seemed in constant agitation. The effect was very much that of a white flag, or the canvas of a tent,

waved by a strong wind. The streamers shifted with corresponding rapidity, dividing and subdividing till they formed narrow bars and streaks of light which shifted like the rays of a chromatrope, fatiguing and baffling the eye that tried to follow their changes. The illustration in 'Mr. Symons's Meteorological Magazine' gives a very fair idea of this part of the phenomena, which continued for the rest of the night. Meanwhile the luminous waves *rushed* up with increasing and indescribable energy, producing an effect like that of wreaths of mist driven by a violent wind, or even more like the surface of water swept by furious gusts. This last comparison will perhaps give a better idea of it than any other. (There was no wind at the earth's surface.) These swept up to and beyond the zenith, and it was curious to notice how, when they crossed the sky overhead, patches of light would appear where none had been before, and always in the same place, just as on breathing over a looking-glass some places retain the breath longer than others.

From 10^h to 10^h 45^m I was indoors, but the phenomena were going on as before when I came out again. However, they gradually subsided, and by 12^h there was only a pulsating glow to about 30° from the horizon. Suddenly a streamer shot up in the north-east, and while the sky to the west of north, above the bank of glow, was tolerably quiet, the phenomena all reappeared (rays, waves, and rushes of light) with renewed energy in the north-east. This time the east portion of the aurora assumed a deep blood-red colour, like the end of a stormy sunset, bright enough to impart to some small clouds floating over it a rich purple hue. The effect of the stars shining through this was very singular; and as the waves of light rushed over it, they seemed to sweep the red away before them, and produced a beautiful effect like that of shot-silk.

This, too, subsided quickly, and was followed immediately by a similar but more vigorous display in the north-west, the red being this time on the west limit. Then the whole sky considerably south of east and west, and beyond the zenith, seemed to break out at once into the most fantastic forms, mostly like mare's-tail clouds, or flocks of combed wool, or again with parallel bars of all sizes and directions, which appeared and disappeared faster than the eye could follow them. At one time a sort of band or corona formed about 20° from the zenith, and seemed itself to be a centre of action. Meanwhile the glow, with its constant flicker

of rays, continued all round the north horizon, resembling, except in colour, the glow from an iron-furnace, and sending up these clouds, as before, that swept with amazing rapidity far beyond the zenith, and in some cases down nearly to the south horizon.

Setting fancy aside, the words "blood and fire, and vapour of smoke," occurred to the mind as the most concise and graphic description that could be given. Our Welsh driver looked up with awe, and another countryman remarked,—“There's something very strange in the sky to-night.”

This account may seem to you highly coloured, but it is in fact a very sober and inadequate description of one of the most remarkable phenomena which I have ever witnessed.

By 1^h 30^m the sky had a good deal clouded over; but up to 3^h A.M., when I went indoors, the same kind of phenomena could be seen through the gaps. Indeed, from the appearance of the clouds during the whole of the 25th, I believe the aurora was continued, and it was very visible, though without the more remarkable features, after dark on that evening, the most energetic rays passing, as before, through the pole-star. It had apparently all died out by the 26th.

I see that some of these phenomena are mentioned by Sir John Herschel and others as occurring from time to time; but from the description of remarkable auroras which I have met with, I think so extraordinary a display can hardly have been seen in this country. Dr. Halley described something similar in the 'Philosophical Transactions' for March 1716, but apparently inferior both in intensity and duration. Strangely enough, he notes this as the first aurora he had ever seen, and he was then sixty years old. In the same article he gives extracts from a book printed in 1654, describing the "Burning Spears," seen at London, Jan. 30, 1660, Oct. 7, 1664, and in Brabant twice in 1575. The writer mentions the "Cupola and Cross" which he saw in the "*Chasma*," as he calls it*, of Feb. 1575, and then says:—"A little after, the sky from the northern edge to the zenith seemed to be everywhere on fire with spears and flames continually shooting up; and then "the face of the sky appeared for the space of an hour to be shaken in strange resemblance to a gamester's dice-box, blue and white alternating with each other, with as much change and rapidity of motion as when the rays of the sun are reflected from a mirror." Again, in September of the same year (1575),

* This would more resemble the aurora of the 24th of October last.

he says of another,—“It was indeed less awful, but more varied and confused..... For in it were seen many luminous arches, from which appeared to rise spears, swords, and cities, with towns. There were rays running out in every direction, and flights and conflicts of clouds; they appeared and disappeared by turns, and by a wonderful change were converted into a circle.”

This will be seen to be very much of the same character as the one I have described.

Since I began this letter, the auroræ of the 24th and 25th of *October* have occurred, of which you will have doubtless many reports. They, too, were remarkable, but of a totally different kind; and the causes of the difference would be an interesting subject of investigation.

Padre Prof. F. DENZA, Hon. Mem. Met. Soc. Observatoire de
Moncalièri, Piémont, Italie.

Une magnifique aurore polaire a été observée en Piémont le 24-25 de ce mois de Septembre, la plus belle qui ait été observée jusqu'ici dans ces contrées. Le phénomène apparut en diverses contrées du Piémont, dans les alentours de Parme et ailleurs; mais les observations les plus exactes et les plus soignées ont été faites par le Rev. Pierre Maggi, à la station de Volpeglino, près de Tortona, dont voici la position géographique: lat. boréale $44^{\circ} 53'$, long. ouest de Rome $3^{\circ} 39'$. Cette apparition eut lieu le 24 Septembre vers les $10^h 20^m$ du soir, mais on ne commença à l'observer régulièrement que le 25 à $1^h 20^m$.

Dans ce moment une belle lumière rouge de feu jaillissait de la région du ciel comprise entre les étoiles η , ζ , ϵ , δ , γ Ursæ Majoris, et s'étendait jusqu'à l'horizon du nord, tandis que dans presque tout l'espace compris entre δ , γ , α , β , de la même constellation il s'élevait une colonne de lumière grisâtre, haute 40° . Plusieurs autres colonnes lumineuses apparurent à l'ouest et à l'est, en sorte que vers les 2^h , le côté nord du ciel était entièrement inondé d'une très-brillante lumière qui s'étendait sur 113° de longueur entre α Lyræ et α Ursæ Majoris avec une hauteur de 40° . Cette lumière passant par diverses nuances donna enfin au ciel l'aspect d'une mer de lumière d'une couleur rouge de feu.

Cette apparition lumineuse disparut après 15^m pour apparaître de nouveau, et cela pour trois fois avec un mouvement ondulatoire, soit vers l'est, soit vers l'ouest. Cependant la partie la plus lumineuse se trouvait toujours vers le nord, embrassant une zone de 30° de largeur et 40° de longueur.

Le moment où le phénomène se montra dans toute sa splendeur, fut vers les 8^h du matin. ; car alors la lumière de l'aurore embrassait vers le nord une étendue de 118° sur une largeur de presque 45°. Dans ce moment la lumière était si intense que beaucoup de monde en fut étonné, et quelques-uns en furent remplis d'épouvante, croyant que ce fut le reflet d'une immense incendie. Les colonnes de lumière devinrent ensuite plus nombreuses et plus brillantes, et vers les 8^h 30^m une de ces colonnes s'éleva jusqu'à 57° au-dessus de l'horizon. Il n'est pas possible de décrire la beauté et la variété des nuances de cette magnifique aurore : elles se succédaient avec une étonnante rapidité en passant du gris au jaunâtre, puis au blanc, puis au rose, puis enfin à un très-brillant rouge de feu.

La clarté du météore était si intense qu'on pouvait encore la voir aux premières lueurs du jour : elle ne fut éclipsée que par la croissante lumière du soleil. M. Maggi put l'observer jusqu'à 5^h 10^m mat. Cela prouve que le phénomène dût se prolonger pendant la journée du 25. En effet dans la soirée du même jour, aussitôt après les crépuscule, vers les 8^h du soir, le côté nord du ciel apparut de nouveau à Volpeglino tout coloré par une teinte rougeâtre, sur une longueur de 116° (entre le cœur de Charles et α Aurigæ) et 35° de hauteur. À 9^h on vit encore quelques colonnes de lumière rouge-feu, qui s'élevaient jusqu'aux β et γ . Ursæ Majoris à 40° au-dessus de l'horizon, et à 10^h 30^m tout avait disparu.

Le magnétomètre de Gauss et le biflaire de notre observatoire étaient fortement agités les jours 24 et 25, mais spécialement le soir du jour 24. Le baromètre et le thermomètre s'abaissèrent rapidement le jour 25, et le soleil montrait un grand nombre de tâches.

Les correspondances télégraphiques avec l'étranger étant interrompues, on ne peut pas encore connaître l'étendue du phénomène que je viens de vous décrire.

October 24th, 1870.

WILLIAM C. NASH, F.M.S. of the Magnetical and Meteorological Department, Royal Observatory, Greenwich.

7^h 31^m. Bright white light crossing Auriga; and a sort of ill-formed arch running from Pleiades along south-east horizon. This arch disappeared about 7^h 37^m.

7^h 47^m. Light still prevalent about Auriga (as at 7^h 31^m) and a very dull white arch along the whole northern sky, running through Ursa Major.

7^h 54^m. A brilliant crimson mass of light appeared suddenly above Auriga, extending beyond α Persei: white light along the north, and extending to due west; streamers north.

7^h 57^m to 8^h 12^m. A mass of deep red light extending 270° from S.E. through N. to S.W. Eastern limit, Aries; western, Aquila; the light is crossed by bright white streamers at times; the light and streamers extend beyond the zenith, converging to α Andromedæ. Throughout this time the red mass of light was of extraordinary brilliancy and very persistent; afterwards it gradually faded.

About 8^h 7^m in south a white arch (very perfect) at about altitude 20°, disappeared 8^h 8^m.

8^h 12^m. The most southern limit of the red mass of light is θ Piscium, so that the part of the sky below that star to the south horizon is the *only part* not trenched upon by the red light.

8^h 19^m. A corona of rays formed close to β Pegasi; in south-east there are bright white streamers directed to same point.

8^h 20^m. At this time there are dull red masses of light in west and east; bright white light in north; white streamers across β Aquilæ pointing to β Pegasi.

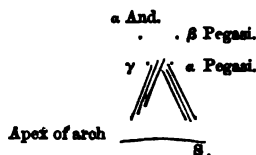
8^h 29^m. Dull brick-red light in west.

8^h 37^m. Part of a brilliant white arch in due south, with apex at altitude 20°, ruddy streamers pointing thus

8^h 37^m. Bright bluish-white light about Taurus, soon faded.

8^h 52^m to 10^h 34^m. Extended line of white light along north about 40°—apex of light at 10^h 34^m γ Ursæ Majoris.

11^h 7^m. Again bright white light under Ursa Major, brilliant ed light to west, near Lyra.



11^h 9^m. Bright streamer across the centre of the red mass, passing across α Lyræ.

11^h 9^m. A fine meteor (>1) with train, fell from near zenith towards Delphinus. Path carried backward would cut Cassiopeia. Duration 1 sec. Colour bluish white.

11^h 10^m. Streamers across β Cygni: the streamers are white and cut across the red mass of light.

11^h 12^m. Very brilliant crimson streamers between Cygnus and Aquila.

11^h 16^m. Bright red mass of light across α Aquilæ and to Sagitta. A fine streamer across α Lyræ, and to δ Cygni—disappeared 11^h 18^m.

11^h 18^m. Bright bluish light along north and north-western horizon.

11^h 19^m. Bright red mass of light close to α Ursæ Majoris.

11^h 22^m. The red light has gone, but there is a decided purple tinge across Ursa Major.

11^h 22^m. Red light again very intense, from Aquila to β Cygni, this light is very intermittent.

11^h 23^m. The red light (near Aquila) disappeared.

11^h 24^m. The red light reappeared in precisely the same place.

11^h 25^m. The red light again disappeared.

11^h 26^m. Meteor = 1st mag. star, white. Path = 6° ; duration 0^s·5; train. Path parallel to joining line of β and η Pegasi; point of appearance midway between β and μ Pegasi—movement towards π Pegasi.

11^h 35^m to 13^h 30^m. Watch maintained, but nothing seen.

13^h 22^m. Meteor fell towards α Lyræ from direction of Cepheus = 1st mag. star, white; 18° ; duration 0^s·6. No train.

THOMAS WRIGHT, F.M.S., Mag. and Met. Dept. Royal Observatory.

6^h 10^m. The clouds that had covered the sky during the whole of the day cleared rapidly away, and exposed the northern portion of the sky illumined by whitish auroral light nearly up to the zenith.

At this time a very large patch of dull red light burst out in the south-west, and reached up to α Ophiuchi; this eventually prolonged itself, and formed a portion of an arch of intense white

light, stretching from the south-west and a little past the meridian, but south of the zenith.

6^h 30^m to 7^h 30^m. The auroral light became intensified, and several small bursts of streamers were observed.

7^h 50^m. The sky from east to west, and past the zenith, became one mass of crimson light crossed by streamers of brilliant yellowish light.

8^h 0^m. A most magnificent streamer passing across Aries, and through the space comprised between α Andromedæ and α , β , and γ Pegasi.

8^h 5^m to 8^h 15^m. The rosy light is gradually fading, but bursts of light occasionally break out.

8^h 20^m. An imperfect corona is now visible a little south of the zenith, the rays intersecting from the south being cut off at their lower ends very sharply.

From this time onwards several smaller displays occurred, but nothing worthy of note took place till 11^h, when the whole western and eastern portions of the sky again became of a brilliant rosy red above, and yellowish streamers shot upwards almost as high as Polaris.

The red tint remained till midnight.

Remark 1.—I think it worthy of notice that though a heavy bank of clouds lay along the northern horizon when the display commenced, they became entirely dissipated without passing across as the other clouds did.

Remark 2.—Two remarkably small, finger-shaped clouds were visible in the north-west at 6^h 40^m, but suddenly disappeared within a few minutes of this time. No others were observed during the remainder of the evening.

Remark 3.—The light of Jupiter was perceptibly tinged red, but that of the principal stars was not.

WILLIAM MARRIOTT, F.M.S., Mag. and Met. Dept. Royal Observatory.

5^h 55^m. A very red light seen in the north and north-west through the breaks in the clouds.

6^h 0^m. The whole northern horizon is of a very rosy appearance, which lasted for some time.

6^h 10^m. A mass of white light very bright below α & β Ophiuchi.

6^h 25^m. The whole northern horizon from east to west, and as high as the zenith, is suffused with a silvery-white light, as bright as the light of the moon.

6^h 30^m. A reddish streamer through Ophiuchus.

6^h 34^m. A very broad red streamer through α Arietis, and α Andromedæ.

6^h 37^m. A very broad band of white light passing up about 7° to the east of α Arietis, and stretching across through Pegasus to the S.S.W., which it reached at 6^h 40^m.

A very red light a little to the west of Aries which continued for a very long time.

6^h 57^m. An arch formed from Aries, through Pegasus and Aquila, to the south-west, with a mass of light produced downwards in Pegasus.

The stars from east to west, and almost up to the zenith in the north, are diminished in brightness by about one half.

7^h 10^m. The light through Aries to the south-west has now disappeared.

At this time I could not see δ Ursæ Majoris through the auroral light.

7^h 18^m. A burst of white light below β Ursæ Majoris.

7^h 19^m. A streamer 5° west of η Ursæ Majoris.

7^h 20^m. A band of light from S.S.W. through Aquila and Pegasus to Aries, which very soon faded.

7^h 23^m. Several streamers shooting up through Ursæ Major.

The streamers can scarcely be distinguished on account of the intensity of the light.

The light concentrated in the E.N.E., and very intense through Auriga and below Perseus.

7^h 30^m. Light becoming intense also in the west.

7^h 33^m. A band of red light shooting up from the east through Aries.

An arch of white light about 10° broad, the apex being in the South Magnetic meridian about 35° high, passing through Cetus, Pisces, and Aquarius, the ends being in the east and south-west.

7^h 38^m. Red light rising in the east and west.

The band of light in the south is now serpent-like in form.

7^h 42^m. The appearance of the sky is now very remarkable; the whole northern horizon is of a beautiful silvery white, a red light rising in the east and west, and a band of white light stretching from the east by south to south-west.

7^h 52^m. Innumerable fine streamers in the north apparently shooting downwards as if from an arch which has formed as high as Polaris.

7^h 54^m. Burst of very fine red streamers in the east.

Streamers shooting up all round from the east to west, and by

7^h 56^m a complete corona was formed.

7^h 57^m. An arch complete has formed.

8^h 0^m. Beautiful red in east and west, and streamers shooting up.

8^h 3^m. Magnificent white streamers in north about $1\frac{1}{2}^{\circ}$ broad.

It is impossible to describe the magnificent effect produced by the beautiful streamers, bright red light, &c. The light was so intense that I could see to read and write distinctly.

8^h 6^m. Two or three fine streamers shooting up in the E.N.E.

The streamers reach past the zenith.

8^h 10^m. The whole northern sky is now one canopy of red light, with white in the centre.

8^h 15^m. Intense white light south of Aries, and also in W.S.W.

8^h 18^m. Streamers converging to a point, from the south-west and east, a few degrees below β Pegasi.

8^h 22^m. Streamers converging, and the crown of the corona is between β and η Pegasi.

8^h 25^m. A band of red light in south-west shooting up a few degrees below α Aquilæ.

8^h 29^m. All the beautiful appearances have now disappeared, and there is only a very bright light in the east, and a dull red light in the west.

8^h 31^m. Three streamers reaching up from α Tauri to square of Pegasus.

8^h 32^m. Red streamer shooting up through α Coronæ and Hercules.

8^h 33^m. A narrow streamer about 7° in length shooting downwards, south, from midway between α and γ Pegasi.

Several more appearing near this, and there is a white light about 20° south of this.

8^h 37^m. A red streamer below α Lyræ.

8^h 40^m. Several faint streamers in N.N.E.

8^h 43^m. Auroral light in magnetic north becoming brighter.

Nothing more was to be seen after this, but a faint light in the north.

10^h 54^m. Several streamers through Ursa Major, and red light rising in the east.

10^h 57^m. Two very well-defined streamers a little to the west of north, and red light in the north.

10^h 59^m. Magnificent burst of streamers all along the north horizon, red at the top and white at the bottom, some reaching 5° higher than Polaris.

11^h 2^m. A burst of very fine streamers.

11^h 4^m. Another burst of very fine crimson streamers in north-west.

11^h 5^m. A beautiful red light in the west, which is spreading to the north.

11^h 7^m. A fine streamer through α Lyrae.

11^h 8^m. A very fine streamer through Cygnus to α Cephei.

11^h 10^m. Intense red light in the west.

11^h 11^m. A lot of streamers through Ursa Major.

11^h 13^m. A very broad streamer in west, about 7° to the right of α Aquilæ; streamers also in Ursa Major.

11^h 15^m. A streamer about 2° to the left of α Lyrae.

11^h 16^m. Magnificent streamers through Ursa Major.

11^h 17^m. A beautiful crimson streamer a little to the right of α Aquilæ.

11^h 31^m. A streamer through ϵ Ursæ Majoris, and another about 3° to the right of α Lyrae.

11^h 46^m. Several streamers shooting up between Polaris and α Lyrae.

11^h 48^m. Several faint streamers in N.N.W.

11^h 54^m. A broad band of white light between Lyra and Cygnus.

11^h 57^m. A patch of white light below ϵ Draconis; also below α Lyrae.

12^h 2^m. A streamer below α Cygni.

12^h 18^m. The auroral light has now become very faint; only a faint light is to be seen below Lyra.

GEORGE L. SCHULTZ, Mag. and Met. Dept. Royal Observatory.

On looking to the sky at about 7^h 50^m, my attention was directed to a most intense red light, as if of a near conflagration, chiefly in the east, extending far around α Tauri and to the zenith, being joined by a similar mass of light from the west, but not of so great an intensity. In a few seconds a solitary streamer appeared in astronomical north, about 20° long and reaching to a little north of zenith. Very shortly after this streamers appeared

at about the altitude of 10° extending from Aquila through north to the Pleiades, reaching and all converging to a point a little to the south of zenith, and west of β Pegasi (see Plate IV.). The streamers were of a greenish appearance, and one broad white streamer was observed in the astronomical meridian. The aurora at this time appeared as two-thirds of a great dome formed above the earth. The streamers converging did not all attenuate in the zenith; but some retained their breadth and shot past the point of convergence so as to cause it to be extremely blurred. The streamers resembled the folds of a curtain; they became fainter, but did not fade altogether till 8 P.M., when the white light, which had been forming under the red at the formation of the corona, became intense all along the northern horizon. The red light shortly after this became abruptly broken, and was separated by a wide band of ordinary sky in astronomical north. I observed during this time that white paper and the white painted facings of the observatory were considerably tinged by the light, also that the light threw a strong shadow. The light of the stars was not affected by the auroral light, but that of Jupiter was distinctly coloured.

Between $8^h 5^m$ and $8^h 20^m$ white light had formed in two large irregular masses, respectively to the south of west and east. Faint red light formed upon these bases and joined to an arch in the constellation of Pegasus. At $8^h 20^m$ a peculiar formation of four thin tufts of streamers were observed to radiate from a point a little to south of β Pegasi towards the south, south-east, and south-west, but disappeared in 25 seconds. In some seconds they appeared again, and the two to northward were elongated and stretching to the bases of white light in the south-east and south-west. This formation seemed to fluctuate in brightness and was still visible at $8^h 25^m$. An arch of deeper red formed above this and the terminal patches of white light. During this time the sky above the north horizon was bright with a fine mild light. It appeared as if fog were rising intersected in places by faint broad streamers of white light. Nearly the whole of the heavens was tinged with red light, with the exception of a space of about 30° over and on the south horizon.

At $8^h 55^m$ an arch of red light formed south of the zenith and at the altitude of Aries, the apex near α Arietis and the bases in south-east and south-west. After this a general red light was visible in different parts of the sky. At $10^h 30^m$ nothing

could be seen save a faint bluish-white light above the north horizon. The sky was remarkably clear. At 11^h red light formed an arch in the north, apex below Polaris, bases under Ursa Major in north-east, and around α Lyrae in north-west. This arch continued for some time, as also some red light in east. I did not observe any thing after this.

W. BISHOP, Mag. and Met. Dept. Royal Observatory.

At 8^h 5^m my attention was called to a red light which tinged the sky in the zenith; this I found was an extremely brilliant arch of a bright rosy-red colour, extending in the zenith right across from east to west. At the same time there were several bright white streamers shooting up to the zenith. At 8^h 18^m, the arch was rapidly becoming fainter, and by 8^h 20^m it had entirely disappeared, with the exception of one or two faint patches dotted here and there over the sky. At 8^h 52^m, I observed three white streamers in the north, shooting up to a point a few degrees below Ursa Major. At 9^h 20^m, the auroral light was still to be seen in the north; but on looking out again about 10^h 30^m, I could see no signs of aurora.

WALTER BARBER, Mag. and Met. Dept. Royal Observatory.

At 6^h the white auroral light was very bright in the north and north-east, and some faint streamers were observed. At 7^h 50^m the sky was illuminated by large masses of crimson light extending from north-east to south-east, and splendid crimson and white streamers meeting in Pegasus. The brilliant appearance gradually faded, but the red light through Aquila remained some little time after the rest. At 8^h 35^m three very bright short streamers, crimson with white edges very high up, met in the zenith and formed part of a corona.

After this nothing worthy of notice occurred until 11^h, when the red light appeared in Ursa Major and some degrees to the east of that constellation. Splendid streamers shot up and reached as high as Polaris. These, together with the red light, travelled rather quickly westwards, and faded away in Aquila: γ Aquila appeared of a red colour through the light. While fading away in the west the light brightened in the north and streamers again shot up. At 12^h the streamers had all disappeared and the auroral light was scarcely perceptible.

October 25th, 1870.

WILLIAM C. NASH, F.M.S., Royal Observatory.

6^h 12^m. Fine rose-coloured streamers passing between β and γ Andromedæ, directed towards α Cygni.

6^h 16^m. Faint white streamers appearing in north; rose-colour in east more intense, also in west now.

6^h 18^m. Fan-like appearance. The rose-coloured streamers spring up principally in east and west, with white streamers along north, and all converge to a point near α Cygni.

6^h 20^m. The whole mass is apparently moving to the south across the zenith; the rays are extremely long, numerous, and rose-coloured in east and west, few and white in the north.

6^h 24^m. Corona at ϵ Cygni; very fine.

6^h 27^m. Corona shifting slowly, now at ζ Cygni.

6^h 32^m. Display less bright. Corona still at ζ Cygni.

6^h 34^m. Light somewhat fitful,—now intense, then less bright. Corona still existing, but badly defined.

6^h 38^m. Mass of pink and white streamers extending to zenith and passing to Cassiopeia and Polaris.

6^h 39^m. Streamers broken up and diffused.

6^h 41^m. Still a great deal of general light in zenith (pink in colour).

6^h 47^m. Fresh bursts of streamers all round from west to east, past north. In south, faint white light; intense rose-coloured light in east. Appearance of corona slightly to the west of ζ Cygni.

6^h 52^m. Large quantity of red light, extending from Aries to Auriga; streamers to zenith; red light in south, below Aquila.

6^h 56^m. Several dark clouds in south-west, with red light above to an altitude of 60°. These clouds appear to be ordinary stratus clouds.

7^h 3^m. The principal display now is in east, below Aries, consisting of pink light (very diffused). Many clouds in all directions.

7^h 17^m to 7^h 27^m. A great deal of general light in nearly all directions, but especially in east.

7^h 32^m. Streamers in north.

7^h 37^m. Many streamers above and through Ursa Major (some coloured). By attentively watching these streamers, I noticed

that they had lateral motion, and were travelling slowly from east to west.

7^h 37^m to 7^h 52^m. Streamers frequently along the whole north; red light sometimes in south.

8^h 3^m to 8^h 42^m. Nothing seen.

8^h 46^m. Dense clouds in north, with white light above; red light in west up to α Lyræ.

8^h 49^m. Bright red light passing close to β Aurigæ and Capella; the red light before mentioned remains near α Lyræ.

8^h 52^m. Very fine streamers reaching to Cassiopeia; clouds rising up from north and north-west.

8^h 54^m. Clouds nearly up to zenith; in north-west they are finely tinged with ruddy light; in the cloudless part of the zenith there is brilliant red light near Cassiopeia.

8^h 56^m. The clouds now extend nearly to south; in north-west and in zenith they are very strongly illuminated by bright red light.

9^h 1^m. The clouds have all disappeared, except a few dense fragments in north-west; the auroral light is nearly as before; brilliant red light in W.N.W. near α Lyræ; long white streamers in north.

9^h 4^m. No red light or streamers now; only in north irregular masses of white light interspersed with dark masses.

9^h 8^m. The sky now appears to be almost covered with thin cloud; the light in the north as at 9^h 4^m, but dark masses greater.

9^h 12^m. Light patches more numerous in north; dark patches many.

9^h 17^m. Clouds off in north-west, very cloudy elsewhere.

9^h 26^m to 9^h 28^m. Red streamers to Polaris; sky clear, except low down in north.

9^h 29^m to 9^h 53^m. No observations.

9^h 54^m. Fine red streamers in north-west.

9^h 57^m. Very cloudy.

10^h 15^m. Clouds all off; red patch across Ursa Major; bluish-white light along north horizon. [The clouds clear off and appear very rapidly.]

10^h 31^m. Sky almost covered with cloud.

10^h 42^m. Sky cleared; white light along north.

11^h 8^m. Very hazy; cloudless; no auroral light.

11^h 33^m. Do. do. do.

12^h to 13^h. No traces of aurora; cloudless; hazy.

October 26.

7^h to 8^h. Sky cloudless ; no auroral signs.

8^h 14^m. Auroral appearances, consisting of illuminated, thin clouds, to the left of Ursa Major.

8^h 19^m. Black patch just under Ursa Major, and small detached fragments to N.N.E.

8^h 31^m to 9^h 40^m. Dull light along N.N.W. to about an altitude of 20° ; occasionally black patches.

10^h. Nothing seen.

[Between 8^h and 9^h vivid lightning seen occasionally in south-east.]

October 25.

THOMAS WRIGHT, F.M.S., Royal Observatory.

During the whole of the afternoon of this day the clouds in the north seemed to be disturbed, and arranged themselves at times in forms like arches, and sometimes in parallel bands, stretching across the sky from north to south.

At 6^h P.M. there was a distinct burst of red light in the east and another one in the west, and yellowish streamers shot across them from time to time.

Between 6^h 15^m and 6^h 20^m a magnificent corona had formed, the point of intersection being close to ϵ Cygni.

Several streamers, in various azimuths, were observed between 6^h 30^m and 7^h 30^m.

First-magnitude stars, in shining through the red light, did not appear to partake of the colour, but their light was the same as usual.

From 8^h onwards, my attention was wholly devoted to observations of the magnets when the traces went off the sheets.

WILLIAM MARRIOTT, F.M.S., Royal Observatory.

5^h 50^m. A bright band of rosy light, stretching across from east to west, a little to the south of the zenith.

5^h 54^m. It has now become much brighter, and is of a pink colour.

5^h 55^m. A corona forming, the rays converging to a point near the middle of Cepheus, all of a beautiful pink colour.

6^h 0^m. Streamers shooting up from east to west all along the north, and are converging in the pole of the dipping-needle; the southern sky is illuminated with a pinkish light.

6^h 2^m. White streamers shooting up in the north-east.

6^h 3^m. Intense crimson light in the west.

6^h 6^m. Streamers shooting up to a point in Cepheus.

6^h 8^m. A fresh burst of crimson streamers, and arranging themselves in the form of a corona.

6^h 9^m. The light in the south-west in Ophiuchus is of an intense red, and the light in the east is of a dull pinkish colour.

6^h 11^m. Another burst of streamers through Cygnus.

6^h 13^m. A very broad streamer in the E.N.E., shooting up through β and γ Andromedæ.

6^h 14^m. The light in the west diminishing, but in the east it is increasing, and some very well-defined streamers are shooting up.

6^h 16^m. Streamers shooting up all along the north.

6^h 17^m. Streamers shooting up, and all pointing to the pole of the dipping-needle.

6^h 19^m. An arch of red light in the north, the apex nearly in the zenith, and streamers all along the arch.

6^h 22^m. A complete canopy of crimson light, with streamers all converging to a point about 10° or 15° below γ Cephei.

6^h 25^m. Streamers of a red, white, and green colour in the W.S.W. reaching up to Cepheus.

6^h 30^m to 7^h 10^m. No observations made; away observing the magnets.

7^h 13^m. Crimson streamers shooting up from the south in the magnetic meridian (these were also seen by Mr. Glaisher), and bright red light in the south-west.

7^h 15^m. Bright red light in the south-east.

7^h 18^m. Red light all along the southern sky, and a band of light stretching up from the S.S.W. through α Aquilæ to Cepheus.

7^h 20^m. Red streamers again shooting up from the south.

7^h 22^m. A red streamer shooting up from the south about 3° to the right of α Pegasi, and reaching up almost to the zenith.

7^h 42^m. Red light in the S.S.W., and several white streamers in the north-west.

7^h 50^m. A rosy red light, something in the form of an arch, from

the south-east to south-west. This red light continued for a very long while.

8^h 35^m. Bright red light from east to west, reaching up above Polaris.

8^h 48^m. A broad band of red light through β Aurigæ.

8^h 49^m. A white streamer through α Cygni, and reaching up to Cassiopeia.

8^h 50^m. Splendid streamers in the north.

8^h 52^m. Intense crimson light in the zenith.

9^h 0^m. The western portion of the sky is of a red colour; white streamers are shooting up in the north; and there is a band of red light from the south-west passing through α Aquarii to α Pegasi.

9^h 2^m. A white streamer a little to the left of α Aquilæ, shooting up to Cassiopeia.

9^h 6^m. The white light in the northern horizon is very intense, but it is broken in a very abrupt manner by clouds coming up.

9^h 7^m. A red light rising in the east through β Tauri.

9^h 11^m. Intense white light in the W.S.W.; also a mass of red light between Jupiter and α Tauri.

9^h 14^m. Bright white light in the west, and, as seen through the clouds, is like the setting of the moon.

9^h 16^m. Several white streamers between γ Ursæ Minoris and ζ Draconis.

9^h 18^m. Red light in the west shooting up above α Aquarii.

9^h 24^m. Red light rising also in the north.

9^h 25^m. Several very fine streamers shooting up in the north.

9^h 26^m. Streamer very well defined through β Ursæ Minoris.

9^h 28^m. The whole northern sky is of a very fine rosy colour; red light also in the west.

9^h 40^m. A red arch reaching up from the east through α Orionis, α Tauri, α Arietis, γ Pegasi, and α Aquarii.

9^h 45^m. There is now a very peculiar appearance in the north; black clouds are dotted at almost equal distances over the bright white light, and are all radiating, streamer-like, from the north; red light rising in the north-west.

9^h 50^m. Two well-defined crimson streamers, one through α Cygni and the other a little to the left.

9^h 51^m. Two streamers through β and γ Ursæ Minoris.

9^h 53^m. Intense rosy light about 2° to the left of α Lyræ.

9^h 54^m. Three magnificent streamers, one between α Lyrae and α Cygni, one through α Cygni, and the third a little to the right of that star.

9^h 56^m. A narrow streamer from α Ceti passing through β Arietis.

10^h 0^m. The sky is covered with cloud, except in the east and south; in the east there is still a red light.

10^h 13^m. A crimson streamer through γ Ursa Majoris.

The auroral light now rapidly faded away, and at 12^h no signs of its presence were visible.

GEORGE L. SCHULTZ, Royal Observatory.

The first of the continuance of the aurora I observed at 5^h 45^m P.M., when a rosy light shot up from the north-west and reached to the zenith. Nearly at the same time the red light was also seen in the east, where some cirro-cumulus clouds were tinged as if by the reflection of a fire. Faint white streamers mingled with the light shooting up through Ursa Major, and in the light first noticed in the north-west. The two patches of light had soon formed to an arch, uniting in the zenith, and an arch of deeper red formed beneath Polaris. The red light is very intense in the triangle of α Lyrae, Cygni, and Aquilæ. At 5^h 55^m a thin streamer of curved shape appeared in zenith, with its convex side towards the south-east. After this the rosy light continued for a long time, occasionally faint and afterwards bright. Very bright white streamers shot up from the north-west and north-east, mingling with the red light, becoming of a fine flesh-colour, and generally uniting a little south of the zenith near the star α Cygni.

6^h. 44^m. Red burst a little west of magnetic north, and streamers from north horizon. Light in south-east becoming faint.

6^h 49^m. Streamers and red light bursting upwards in north-east. This is becoming very conspicuous. Dark clouds like strati, a little over north horizon noticed, also in east and south-east.

6^h 50^m. Red light again around and below Polaris; a batch of white streamers on red ground 30° west of γ Ursa Majoris.

7^h 21^m. The sky south of zenith is covered with stratus of a red

tint. White light, in patches of streamers on north horizon, surmounted by faint dark red light, is brightest in north-east, east of Ursa Major, and to the left of and below α Aurigæ.

7^h 25^m. Clouds clearing away from south-west towards the east. Red light south of α Aquilæ.

7^h 27^m. White streamers of irregular shape in magnetic north. Very little red light visible in north.

7^h 28^m 40^s. Streamers in Pegasus east of magnetic meridian, and inclined to it at an angle of about 20°, shooting up from the south. Intense red light around and below the constellation of Pegasus, white streamers in it converging to δ Pegasi; the streamers are shooting upwards from the south.

7^h 27^m. Some clouds in north, of a stratus character, forming an arch at an elevation of about 30°, and white light beneath it.

7^h. 58^m. White light in south-west in one large patch.

8^h. A corona is forming, faint streamers are coming from south and east, and pointing to near zenith, between ϵ and δ Pegasi.

8^h 6^m. White streamers becoming conspicuous in north, one particularly, through ζ Ursæ Majoris.

8^h 11^m. White streamers through Ursa Major.

8^h 11^m 20^s. A broad streamer in magnetic meridian, from about 30° above the south horizon, pointing to zenith, but quickly vanishing.

8^h 14^m 10^s. Light in south-east most conspicuous, appears to fluctuate.

8^h 14^m 10^s. A broad band of light, shooting upwards from north horizon, passing a little to east of Polaris, is moving westward.

8^h 18^m. It is west of β and γ Ursæ Minoris. Faint streamers from all parts of north horizon.

From this time to about 10^h 40^m the light and streamers were faint, clouds occasionally covered the sky, and, when clear, faint red light extended from west and east to the south, and a faint white light extended all around the north horizon from west to east.

At about 10^h 40^m thin dark clouds began to rise in north-west and spread along the north horizon. These clouds were at first patchy, but after a time they formed above the horizon, assuming at the lower edge a form similar to a bowl with its convex side downwards. After a time the clouds rose and gave the appear-

ance of a mackerel sky, the light shining behind the clouds. Thin clouds arose—the light became fainter, and nothing more was observed.

WALTER BISHOP, Royal Observatory.

At 5^h 52^m I observed a brilliant mass of light forming in the zenith and stretching right across from east to west. It was at first of a pale pink colour, but rapidly deepening, it became a bright rosy red, as on the previous evening. The whole of the sky south of the zenith was illuminated by this mass of light, but nothing was as yet seen north of zenith.

At 5^h 54^m a splendid corona, of a bright pink colour, was formed a little south of the zenith.

At 6^h there was a splendid burst of streamers from all points between the east, north, and west. The streamers were chiefly of a pink colour, and all converged towards a point close to α Lyrae.

At 6^h 18^m there was a splendid burst of extremely bright pink streamers in the east, shooting up to a very great altitude.

At 6^h 16^m there was a splendid burst of extremely bright pink and white streamers, shooting up from the east, north, and west, and converging to a point in the midst of the constellation of Cygnus. These streamers presented the form of a monstrous fan, or the tail of a peacock. There was a peculiar thing worthy of notice: all the white streamers seemed to come from the north, and the pink from the east and west.

At 6^h 30^m there was a burst of green streamers in the north. These were rather bright, but shot up to a very short distance, and did not last longer than twenty seconds.

At 6^h 45^m there was a burst of bright white streamers, crossing Ursa Major, and shooting up to the zenith.

At 6^h 59^m there were one or two faint pink streamers shooting up in the south.

At 7^h 36^m there were several brilliant streamers, of a white colour, shooting across Ursa Major, and stretching up to β and γ Draconis, and β and γ Ursæ Minoris. These streamers moved westward, and at the same time elongated.

After this time there was nothing much to see, the sky in the north and zenith being for the most part covered with cloud,

which came up from the south-west. One or two more bursts of streamers were observed in the south, and also two small masses of pink light in the south-east and south-west.

At 10^h 10^m there were two bright pink streamers, shooting up across Ursa Major.

CORRESPONDENCE, &c.

Jellah-Coffee,

September 7, 1870.

DEAR SIR,—Yesterday morning, at a quarter-past ten, a beautiful halo or circular rainbow surrounded the sun. The ship was off Cape St. Paul's, in the Gulf of Guinea, in latitude 5° 20' N. and longitude 0° 28' W., the thermometer standing at 80°. The dew during the night had been unusually heavy, but the morning was fine; the air somewhat hazy, with long streaks of thin cloud; the wind was southerly, with a force of about 3, the water smooth.

The following approximate measurements were taken with a sextant:—

Internal diameter	43 36
External diameter	44 50
Lower edge from the horizon	43 50
Sun's altitude	65 0

The colours of the halo were not bright, like those of a rainbow, but very soft, as in a lunar rainbow. The innermost colour was a soft, murky, brick-red, changing into orange, yellow, sea-green, and light-blue fading into white. All the colours were subdued, and very harmonious, but clear, distinct, and not dazzling to look at.

The sky just inside the circle appeared dark, increasing in light as it approached the sun. Immediately outside the halo the sky was very light, with a brightness fading off, but which could be traced for about ten degrees. The appearance lasted half an hour, when it faded suddenly away.

No doubt this is a phenomenon which many Fellows can understand; but I send the account of it to you in case you think it will prove interesting to the Meteorological Society.

I am, dear Sir,

Faithfully yours,

EDMUND H. VERNEY,

Commander H.M.S. 'Growler.'

To the Secretary to the Meteorological Society.

*Extract from a letter from Sergeant LYNE, Scutari, to the
Rev. R. MAIN.*

Scutari, 13th May, 1870.

"DEAR SIR,—After sending you 'the weather of 1869' (see Proc. Met. Soc. vol. v. No. 47, pp. 61–67), I commenced tabulating the observations of the past five years, with the view of sending you at some future time the means and extremes due to that period.

"On the 19th April I was fortunate in observing, at 9 A.M., a very beautiful halo around the sun, coloured rainbow-like, and very distinct, in connexion with which was an arc of light, passing through the sun, and forming a large circle, apparently nearly, if not quite, parallel with the horizon, perfectly defined throughout, but crossed in two or three places in the north-west and west by cirrus clouds. The colours of the halo appeared to run into the band where the two intersected.

"The circle disappeared in half an hour from my first observing it, and the colour of the halo then gradually faded away.

"The halo, however, remained until near noon as a band of light, darkest on the inside.

"The weather at the time was fine. In the afternoon the sky became overcast; a dispersion of cloud took place after sunset; during the night it again became overcast; rain set in about 6 A.M. next morning, and continued several hours. The two days immediately preceding the phenomena were fine, the 17th being more than usually clear.

(Signed) "WM. H. LYNE."

At Sea, off Gibraltar, H.M.S. 'Prince Consort.'

Capt. G. L. TUPMAN, R.M.A., F.M.S.

A very rare phenomenon in these latitudes, the aurora borealis, having been seen in great beauty on the evenings of the 24th and 25th inst., I take the liberty of sending you the following imperfect account of it:—

On the 24th it became visible immediately after dusk as an extensive crimson glow above the northern horizon. At 7^h 40^m, when my attention was first called to it, the northern heavens, for some 60° in azimuth and 30° in altitude, were gorgeously illuminated. The distribution of the light was unequal, two or three patches being much brighter than the general arch.

Occasionally long, narrow streamers, about 1° in width and from 10° to 30° in length, of a lighter tint, made their appearance and moved steadily but slowly towards the west, as the spokes of a huge celestial wheel, revolving very slowly in a direction contrary to that of the rotation of the earth. As the streamers only remained visible a few minutes, they shifted their places among the stars but a few degrees. Every streamer seen exhibited this peculiar motion. At 8^h P.M., Gibraltar mean time, the positions of two of them were accurately noted by the stars. One extended from α Ursæ to a point midway between α and δ Ursæ Minoris. The other was exactly parallel to the line joining η and ϵ Draconis, and 2° to the right, or on the side of the pole. The stars β and γ Ursæ Minoris were considered to indicate about the vertex of the arch, streamers passing between them being exactly vertical.

Judging from memory, the general colour was about that of the line A of the solar spectrum. Some of the rays were nearly white. After 8 o'clock it diminished in intensity. At 9 a faint but extensive glow remained, and by 11 all trace had disappeared.

The next evening (25th) the display was very similar, but the period of maximum brilliancy occurred about an hour earlier, from 6^h 30^m to 7 P.M. The colour was precisely the same.

At 6^h 25^m I noted accurately the direction of two rays or streamers: one covered the stars η Ursæ and 16 Draconis (B. A. C. 5574), the other α Ursæ and ζ Ursæ Minoris; and the centre of the arch was again considered to be about β and γ Ursæ Minoris. The stars α Persei, Polaris, β Ursæ Minoris, and

α Coronæ were situated along the upper limb of the arch, which, however, was very ill defined. The colour was abruptly cut off about 4° above the horizon all along.

On the 26th, about the same time, a very faint aurora was seen.

On the 27th, none whatever.

The point in space from which the streamers appeared to radiate was in R.A. 161° , N.P.D. 102° , at 8 P.M. precisely, on the 24th; and in R.A. 137° , N.P.D. 99° , at 6^h 25^m, on the 25th.

The corresponding *terrestrial* coordinates are:—

On 24th, 67° below the horizon of Gibraltar, on the azimuth, N. $18\frac{1}{2}^{\circ}$ W.

On 25th, 62° below the horizon of Gibraltar, on the azimuth, N. 14° W.

The variation of the magnetic needle at Gibraltar is W. $19^{\circ} 19'$ (1870).

Cramlington, Northumberland.

THOS. SOPWITH, M.A., F.R.S., F.M.S.

At 6 P.M. this evening (Oct. 25), in a sitting-room at Cramlington, my attention was drawn to a bright red colour in the sky towards the south, and midway between the horizon and zenith. On looking out from the grounds in front of the house a very large portion of the sky was filled by aurora borealis of a more brilliant character than I had ever before witnessed. Although the phenomena were presented in almost every part of the sky, yet the chief interest was concentrated in a very wide and tolerably well defined series of parallel, or nearly parallel, coruscations, which, in the aggregate of their width, presented an approximation to an arch extending from the western horizon to that of the north-east. The *variations*, though occurring at intervals of a few minutes, were, as regards this arch, by no means so frequent as I have usually seen in the movement and apparent interchange, as it were, of the ordinary streamers of Aurora in the northern horizon. But that which preeminently distinguished them from ordinary streamers was, *first*, their position, emanating, as it were, from a sort of zenith of the arch (which pole or zenith I suppose to have been about 20° south of the true zenith), and, *second*, the extreme brilliance of colour—rose-red tints and pale green being very pro-

minent. I continued to observe the several changes at intervals during two hours. At 6^h 15^m the aurora had diminished in importance, both as regards definite form and decided colour; but 15^m later the aspect was more brilliant than when I first saw it. The arch was again well defined, the colours again very prominent, but most especially so in that part of the arch situated about 40° above the north-east horizon. Here, for a space of some 20° by 8° or 9°, an irregular oval form was of an intense red colour, much more so than any other part of the heavens. At 8 P.M. the Pleiades occupied nearly the centre of this space; but the bright rose-colour of 6^h 30^m had then vanished from that spot. It had moved, as it were, some 30° to the south, and assumed a dark blood-red colour. At intervals the central portion of the sky seemed as if partially covered by electric clouds of whitish light; but these were united to the horizon by streamers, which frequently varied from light green to dark red. During nearly all this time ordinary streamers were seen all along the northern horizon, but presenting only the frequent and well-known aspects called the "northern lights."

By far the most interesting object, next to the remarkable brightness of colour, was the junction or meeting of radiating streams at a point about 20° south of zenith. At 8 the arch-like phenomena, though less prominently marked, were ranged in a direction about 24° east of south.

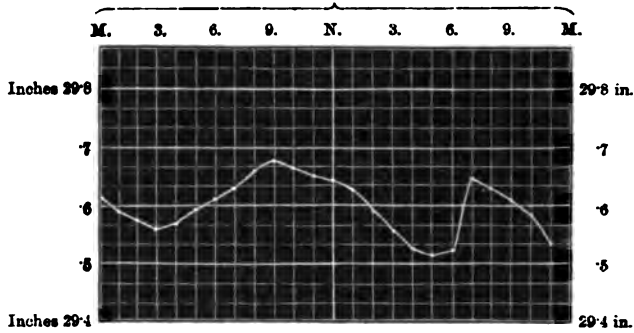
At 10, aurora spread over all the northern horizon from west to north-east,—long lines of coloured light stretching 60° or 70°, red and pale green. The zenith and all the central part of the heavens have floating clouds of light formed of sudden coruscations, sometimes detached; yet again they form an arch or dome-like configuration, meeting in an apex 20° south of Cassiopeia, which is now nearly in the true zenith. The northern horizon is a flood of light, with radiating streams of light; and red and green again appears, but not so brilliant as before.

LIEUT.-COL. TENNANT—Storm at Calcutta.

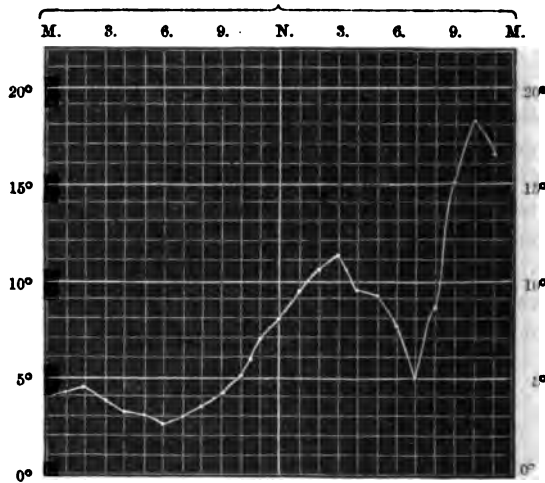
20th day—Civil time.

BAROMETER.

Hours.

Range between the Reading of Dry- and Wet-bulb
THERMOMETERS.

Hours.





PHASE OF THE "AURORA BOREALIS"
AS SEEN ON THE 24TH OCT. 1870.

ADVERTISEMENTS.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	15	0
Above five lines, per line	0	0	6	Colo. half-sheet and less	1	10	0
Half a page	0	17	0	„ whole sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

SESSION 1870-71,

25 GREAT GEORGE STREET, WESTMINSTER, S.W.

1870. November	10	1871. March	11
1871. January	18	„ April	18
„ February	15	„ June (1871a.)	2

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES.

Newly arranged, containing Corrections for Temperature, reduced to different Places of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

*Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. BELVILLE'S *Handbook*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, &c., Red Lion Court, Fleet Street, &c.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, F.R.S., SECRETARY.

1871, JANUARY 18.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
XXIV. Heights and Velocities of Shooting Stars observed in Eastland in August 1870.—Prof. A. S. Herschel, B.A., F.R.A.S. (Three Winkles.)	247
XXV. On the Remarkable Period of continuous Cold Weather from 1870, December 21st. to 1871, January 6th.—James Glaisher, F.R.S., Secretary.	254
XXVI. Meteorological Observations in 1869 at Martindale, Northham, New Zealand, lat. 45° 17' S., long. 168° 50' E., highest place reached 79 feet, distance from sea 10 miles.—G. Ross Martin, F.R.S., Director of Meteorological Stations.	258
XXVII. Description and Figure of Mr. Odeur's Anemometer as arranged with Spiral Apparatus. (Woodward.)	263

Correspondence, &c.:—

On a Cyclonic Storm. Extract from a Letter from A. V. Norring Raa to W. Huggins, Esq., D.C.L., F.R.S.	266
---	-----

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1871, March.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1871, JANUARY 18. [No. 52.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Eyre, Rev. William L. W., *Huntley, Gloucestershire*,
was balloted for and duly elected a Fellow of the Society.

The names of Three Candidates for admission into the Society
were read.

XXIV. *Heights and Velocities of Shooting-Stars observed in England in August 1870.* By Prof. A. S. HERSCHEL, B.A.,
F.R.A.S.

ON the nights of the 5th–12th of August, 1870, simultaneous observations of shooting-stars were made, at the suggestion of the Luminous-Meteor Committee of the British Association, by practised observers in different parts of England and Scotland, at several widely separated stations, the principal object of the observations being to determine the time (or times) of maximum, and the position, or changes of position, of the radiant-point of the meteoric shower, for two or three nights before and after the annual date of the 10th of August. The Committee had also in view to determine as accurately as possible the heights and velocities of any shooting-stars which might be simultaneously observed at more

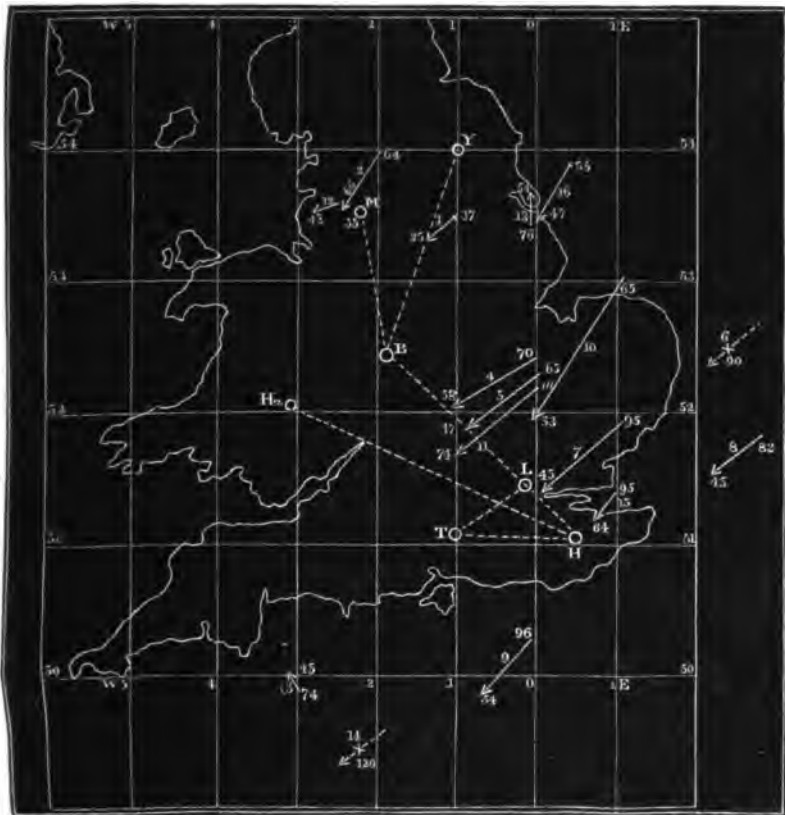
than one of the stations. From most of the observers who took part in the observations, favourable reports were received of the state of the sky, and of the visibility of the meteors during the hours between 10^h and 12^h P.M. on some of the nights appointed by the Committee for the simultaneous watch.

Meteors appeared to be almost equally abundant on the nights of the 10th and 11th; and from the occurrence of lulls, or occasional intervals of half-an-hour, during which few or no meteors were visible, followed by a distinct group or rapid succession of ten or twelve meteors in about as many minutes, no exact time of maximum abundance of the meteors was clearly indicated during the display. A group of nine shooting-stars was recorded at Greenwich during the quarter of an hour from 10^h 18^m to 10^h 33^m P.M. on the night of the 10th; and another of six meteors at Hawkhurst in six minutes, between 0^h 12^m and 0^h 18^m A.M. on the 11th. On the night of the 11th, occasional cessations of the meteoric current were also remarked, followed by groups of shooting-stars of considerably less intensity than those recorded on the previous night. The position of the radiant-point on the night of the 10th was considered by Mr. T. Crumplen to be near η Persei, by Mr. Howlett near σ Persei, and by Mr. A. S. Herschel between α and γ Persei. On the nights of the 11th and 12th, the same observers regarded the position of the radiant-point as being more northerly, and considered its place to be respectively near χ Persei, q Camelopardi, and between η Persei and ϵ Cassiopeie. The Star-chart of the British Association for the registry of meteor-observations in August, was distributed to the observers; and, in spite of the unfavourable condition of moonlight and of the cloudy state of the sky at intervals during the shower, it enabled the position of the radiant-point to be pretty exactly fixed. On the nights of the 5th, 6th, and 9th its place was considered by Mr. Greg to occupy a radiant-region with a centre about R.A. 37°, N. Decl. 59°, between k Persei and ϵ Cassiopeie, and elongated in a direction between those stars. Of the shooting-stars recorded at Birmingham, on each night of the shower, by Mr. Wood, 12 per cent. radiated from near ϵ Cassiopeie, 30 per cent. from near η , and 24 per cent. from near γ Persei. The coexistence of radiant-points near the Pole-star, in Cygnus and in Pegasus, and of one southern radiant-point in Sagittarius (already noticed by Mr. Heis and Dr. Neumayer) was noticed by Mr. Wood. Mr. J. E. Clark, at York, observed an elongated radiant-region of the Perseids, between γ Persei and

δ , ϵ Cassiopeiæ; and some meteors with curved paths were seen by the Rev. Mr. Webb at Hay.

Although the observers were not always simultaneously on the watch, and many meteors were concealed by clouds and by the bright moonlight, which were yet visible at distant stations, sixteen of the shooting-stars whose apparent paths were traced upon the charts, are found to have been simultaneously observed. The situation of the stations at which the corresponding observations were made, and of the places over which the meteors doubly observed appear to have been vertical, together with the computed heights of their visible tracks above the earth, are shown upon the accompanying Map (fig. 1).

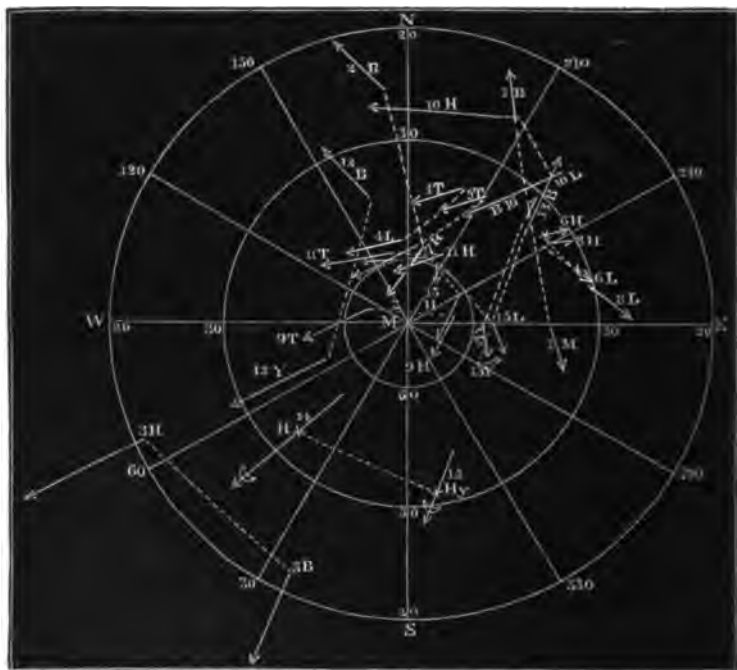
Fig. 1.



Heights and positions of shooting-stars observed in England, in August 1870.

Fig. 2 is a plane-perspective projection of the apparent paths of the same meteors, as observed at the different pairs of stations

Fig. 2.



Apparent paths of shooting-stars doubly observed at different stations in England, in August 1870, at (B.) Birmingham, (H.) Hawkhurst, (Hy.) Hay, (L.) London, (M.) Manchester, (T.) East Tisted, Hants, (Y.) York.

where the times and other particulars of their appearance were simultaneously recorded. From an inspection of figs. 1 & 2, it will be seen that the apparent path of each meteor, as seen by the observer at the first of such a pair of distant stations, is displaced in the sky, relatively to its apparent path as seen by the observer at the second station, in the direction of a straight line drawn from the first station to the second station upon the map. Tracings of the meteor-tracks, reported upon the star-charts by each of the observers whose accounts of the meteor-shower were received by the Committee, having been made upon transparent paper, and the proper allowance for the apparent diurnal motion of the sky, during the continuance of the observations, having been

made, so as to reduce the recorded paths (as shown in fig. 2) to apparent altitudes and azimuths for the horizon of Greenwich, the tracings for each pair of stations, thus obtained, were then superposed, and the meteors simultaneously observed at two distant stations were at once easily identified by the above relative position of their apparent tracks, together with the near coincidence of the times of observation and of the brightness and other peculiarities (such as the persistent streak &c.) of the meteor's appearance, as recorded with more or less exactness, and often with a close approach to complete agreement between the observers, at the two connected stations.

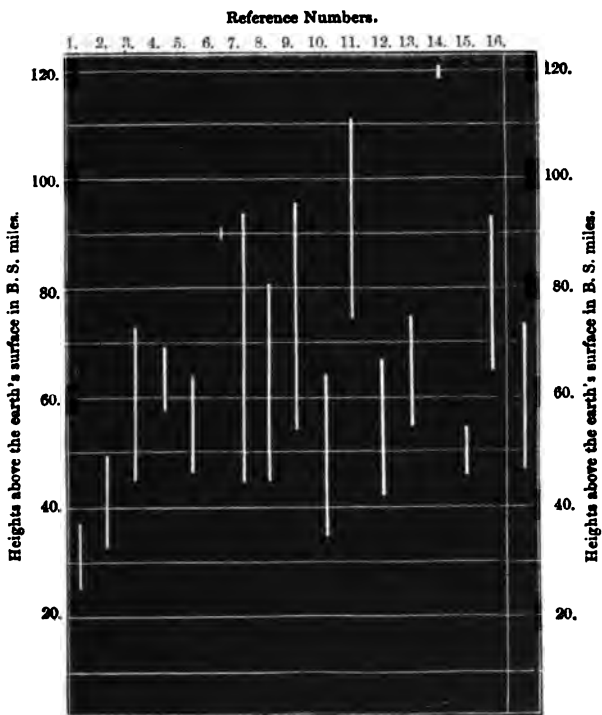
The difficulty of seeing small stars for reference during the full-moon light which prevailed on the night of the 10th of August, and the consequent uncertainty which was felt in describing the apparent paths of the meteors by the stars, together with the fact that the persistent light-streaks which usually accompany the August shooting-stars were on this occasion hardly perceptible from the same cause, will be sufficient to account for a want of exact agreement, in many cases, between the direction of displacement of the meteor-tracks of the same meteor, simultaneously seen at two distant places, and the direction of the straight line drawn from one station to the other upon the map, as well as to explain the different estimates of brightness, length of path, and duration and persistency of the light-streak left by the same meteor, as recorded by the observers in their reports. The condition, however, of parallel displacement of the observed meteor-tracks in the direction of a straight line connecting two distant meteor-observatories, when only a few meteors are observed, and when the apparent paths are recorded upon the star-charts constructed on the gnomonic or plane-perspective projection, with the zenith in the centre of the map, is a sufficiently safe and ready guide to enable observers to dispense with keeping true Greenwich time to a few seconds, and with the use of the telegraph (which has recently been employed with considerable success on the Continent and in America) for the purpose of identifying the observations that refer obviously (in the majority of cases recorded in the present list) to the same meteor, simultaneously observed at two distant stations.

In order to compute the real heights of the meteors whose descriptions at two of the observing-stations were thus identified, the observed places of first appearance and disappearance of the

meteor at the two points of view were first adjusted to each other by small (and in most cases *very sensible*) corrections of the recorded paths, so as to fulfil the condition of parallelism between their line of "parallax" (or projected distance of their apparent displacement in the sky by the effect of distance between the observers) and the straight line joining the two observers' stations on the map. In most cases it was found possible to effect the necessary alterations by shortening or prolonging the apparent paths of the meteor as observed at one or both of the corresponding stations, a few degrees at one, or sometimes at both ends of the visible course which the meteor is recorded to have pursued in the sky; but, especially in cases where the two recorded paths, *prolonged forwards*, would have intersected each other upon the map, since the conclusion would then be (in direct contradiction to their acknowledged astronomical character) that *the meteor shot upwards*, lateral displacements of the point of first appearance, or of disappearance, at the ends of one or both of the recorded paths were found necessary, which, if the radiant-point of the meteor was not known from other observations of its course, or from special considerations of its appearance, are made as small as possible in the observations of the present list. The columns in the Table headed "Adopted apparent places of appearance and disappearance" and "Adopted length of path" were thus obtained, by applying to the recorded paths the smallest possible corrections, which (on the condition of their simultaneous and accordant observation) the recorded meteor-tracks appeared most evidently to require; and the "adopted apparent paths" are those which are represented in the chart, fig. 2. By placing in the same chart, from the column in the Table headed "Apparent places of appearance and disappearance, *observed altitudes and azimuths*," the apparent meteor-tracks which were actually recorded, it will be seen that the adopted corrections which have been applied to the original observations are, in general, not greater than the unavoidable errors of observation of such momentary phenomena, or of interpreting the descriptions, might fairly be expected to explain. Uncertainty appears, in some cases, to exist, if the point where the meteor was first seen, or the direction from which the meteor shot is described as the "point of first appearance;" and this source of error chiefly affects the adopted length of path. An occurrence of this kind of uncertainty is pointed out in the note to the meteor no. 9 of the list (which appears in the Report

of the Luminous-Meteor Committee of the British Association), the computed path of which is probably much longer than was in reality observed. With the observed duration of the meteor's flight, the computed velocity of its motion would, on this account, appear too large; and it was thought desirable, in this case and, for the sake of uniformity, in the cases of the remaining meteors of the list, to increase or diminish the observed times of flight as recorded at each station in the same proportion that the "adopted lengths of path" at the same stations are greater or less than the observed lengths. The numbers in the column of the Table

Fig. 3.



Heights of Shooting-stars observed in England, August 5-11, 1870.

headed "adopted durations" were thus obtained, by a simple proportion, from the numbers in the three preceding columns; and the "average adopted durations" in the following column are the arithmetical means of the numbers for the two stations thus obtained. Comparing the latter with the computed length of path in miles, the real velocities of the meteors were calculated, in

miles per second, as shown in the next column of the Table. The annexed diagram (fig. 8) exhibits the computed heights at first appearance of fourteen meteors of the list, together with the probable heights of the centre of the path of the meteors (nos. 6 and 14) whose entire paths could not be correctly calculated from the observations. The average heights at appearance and disappearance (74 and 47 miles), as shown by the vertical line at the end of the diagram, are less than those of twenty meteors (82 and 58 miles) similarly observed in August 1868; while the average length of path and velocity of the meteors observed in August 1870 (48 miles and 46 miles per second) is greater than that of the shooting-stars observed in August 1868 (omitting two bright ones with exceptionally long paths, 42 miles and 84 miles per second). The strong light of the full moon, by diminishing the brightness of the meteors, and by extinguishing the small stars of reference near the beginning and end of their apparent course, so as to make only the brightest fixed stars, often at some distance from the meteor's path, available to describe them, may have sensibly increased the apparent length, and have diminished the apparent duration of their already almost momentary flights, so as to exaggerate unduly the real lengths of path, and velocities, which would otherwise result directly from the observations.

Before closing this brief description of the graphical process by which the above heights of shooting-stars were deduced as approximately and as expeditiously as possible from the large number of observations received by the Committee from observers in different parts of England, it may be pointed out that graphical methods of construction upon maps and charts, like those of the British-Association Meteor-atlas, in which the meridians and circles of declination are drawn at intervals of one degree, are, in general, sufficiently accurate for eye-observations of shooting-stars. The average errors unavoidably committed in recording the apparent paths of shooting-stars cannot reasonably be reckoned at less than 1° . But since the errors of observation must, in a great majority of cases, exceed 1° , the calculation of the real paths of shooting-stars, in every case by strict arithmetical rules, will probably furnish fewer and scarcely more reliable results than might be obtained by a simpler and graphical treatment of the observations. By projecting the meteor-tracks recorded at two distant stations during a simultaneous watch (as, for example, the meteor-paths recorded at London and Hawkhurst, L. and H., nos. 6, 7, 8, 10, 15, in fig. 2) by their observed altitudes and azi-

muths upon a single map, and by selecting those shooting-stars which appear, from the direction of their "parallax," and from the coincidence of their times of appearance, to have been simultaneously observed, a simple measurement of the length of the "parallax," in inches, upon the chart, supplies all that is required for the following complete determination of the meteor's real path. It admits of an easy geometrical proof that, if a be the radius of the sphere from which a gnomonic chart like that shown in fig. 2 is constructed (or the distance of the eye in inches, 0.57 inch in fig. 2, from the centre of the plane perspective chart), b the length of the base-line between the two observing-stations (in the case of Hawkhurst and Regent's Park, London, 44 miles), p the "parallax" in inches, measured upon the chart in the direction parallel to the observer's base-line, or the displacement in inches between two points (one upon each of the observed tracks), h representing a single point of the meteor's path at a height miles above the surface of the earth, then in whatever part of the chart the parallax, p , is measured in the manner just described, the height, h , of the meteor-point to which it corresponds is given by the proportion $h : b :: a : p$; or by the simple arithmetical equation

$$h = \frac{ab}{p}, \quad \dots \dots \dots (1)$$

Thus, in the above-selected examples of the meteors H., L., Nos. 7, 8, 10, 15, in fig. 2, a (the principal radius of the chart) is 0.57 inch (viz. that of the circle whose zenith-distance is 45°); b (the distance between the two stations H. and L.) is 44 miles; and the constant product of these numbers, ab , is $0.57 \times 44 = 25.08$. The measured parallaxes, p , for the points of first appearance of the above-selected meteors, as carefully measured as possible upon the chart (fig. 2), are respectively:—

Reference Nos. ...	7	8	10	15	
Measured parallax, p , in inches	0.28	0.32	0.37	0.42	$ab = 25.08$.
Heights at first appearance determined by equation (1).....	89.6	78.4	67.8	59.7	miles*.
Heights at first appearance, from the columns of the Table in this paper.....	95	82	65	55.	miles†.

* Average 73.9 miles.

† Average 74.2 miles.

2 A*

The principal radius, or distance of the eye, from the centre of the plane-perspective star-charts of the British Association Meteor Atlas being 4 inches, the probable error of the resulting heights would be *seven times less* than in the small chart (fig. 2), which is here employed as an illustration of the process of determining the heights, at first appearance and disappearance, of shooting-stars above the surface of the earth. The apparent angular altitudes (or zenith-distances) of the beginning and end-points of the meteor's visible course above the horizon of one of the observers' stations being also known, the places over which it was vertical at its commencement and at its disappearance can then be simply found, from the initial and terminal heights, by a table of natural cotangents (or of tangents), or by resolving, with the help of logarithms, two right-angled triangles, of which all the angles and the heights, or perpendicular sides, are known. The bases of those two triangles will be the distances upon the earth's surface (supposed, in these approximate calculations to be a plane surface) of the observer's station from the places over which the meteor was vertical at first and last; and they will require to be laid down upon a map in the directions, or "azimuths," which the meteor appeared to have, at its commencement and disappearance, from the observers' points of view.

The horizontal extent of the meteor's flight will then be measured upon the map; and the difference of the real heights (already ascertained) of the beginning and end-points of its visible course being the whole vertical extent of its flight, the length of the meteor's real path is found by the common rule for obtaining the hypotenuse of a right-angled triangle the lengths of the two sides of which are known. From the length and the duration of the meteor's flight as noted by one or by both of the observers, the meteor's real velocity can then be found. In this manner the heights and the other particulars of the real paths of the meteors of the present list were determined from the British-Association Star-chart for August, and from the tracings of the meteor-tracks recorded thereon, together with descriptive details of their observations, which the observers whose names are mentioned at the beginning of this paper obligingly undertook to make for the Luminous-Meteor Committee of the British Association, and to ensure their comparison together by forwarding them to the Committee for a general discussion.

A preliminary examination of the shooting-stars recorded on

the nights appointed for the combined meteor-watch, by Mr. Glaisher's staff of observers at the Royal Observatory, Greenwich, with the notes of observers whose records of the meteor-shower have, thus far, been compared together, suffices to identify a considerable number of shooting-stars of the shower observed at Greenwich with bright meteors of the display observed simultaneously and carefully recorded at other stations. The heights of some of these doubly recorded meteors having already been determined, while the remainder are new to the present list, the additional materials which they will furnish for discussion, by comparison with the foregoing particulars of the real heights of some of the August meteors, in 1870, will, it may be expected, form an interesting continuation of this list, and of the graphical method employed to determine their real heights and velocities, which, it is hoped, will shortly be resumed in another paper.

XXV. On the Remarkable Period of continuous Cold Weather from 1870, December 21st, to 1871, January 5th. By JAMES GLAISHER, F.R.S., Secretary.

DURING the months of December 1860 and January 1861, a period of cold weather took place, which for the number of days it continued was very remarkable, although, so far as regards the severity of the weather, it was by no means unprecedented. Since that time, with the exception of a period of eleven days in January 1867, we have not been visited by any unusual continuation of low temperatures until the present winter.

The mean daily temperatures in the month of October 1870, alternated in groups of twos and threes above and below the averages of fifty years, 1814-63; but on the whole 31 days there was a deficiency $0^{\circ}5$ daily. On the 1st of November, the mean daily temperature passed below the average and remained so (with the exception of the 5th) till the 19th, the greatest departure below the average being on the 3rd, when it amounted to 10° , the coldest day, however, being on the 15th, when the temperature was $33^{\circ}7$.

On the 20th a warm period set in and continued till the 29th, the excess over the tens day amounting to $4^{\circ}4$. This was followed by a deficiency of mean daily temperature during the next twelve days, amounting to 8° daily. The following nine days were warm,

with the exception of the 17th; and then commenced the cold period which is the subject of this paper.

On the 21st of December the mean temperature of the air for the day was $27^{\circ}7$, or $11^{\circ}1$ below the average of that day: the temperatures on the three following days were $15^{\circ}1$, 14° , and $15^{\circ}8$ below their respective averages; and this brings us to the 25th, on which day the mean daily temperature amounted to $20^{\circ}6$ only, or 17° below its average, being the coldest day experienced since January 14th, 1867, on which occasion the mean temperature was $18^{\circ}2$, and the coldest Christmas-day since 1860, when the temperature on the 25th was $20^{\circ}2$.

The following are all the instances on which the mean daily temperatures have been lower than that on December 25, 1870, since 1814.

TABLE I.

Year and Date.	Average Temperature of Fifty Years.	Temperature of the Day.	Departure below the Average.
1814, January 10th	$35^{\circ}9$	$19^{\circ}6$	$16^{\circ}3$
1815, " 14th	$36^{\circ}3$	$16^{\circ}2$	$20^{\circ}1$
1816, February 8th	$38^{\circ}9$	$19^{\circ}7$	$19^{\circ}2$
" " 9th	$38^{\circ}9$	$12^{\circ}6$	$26^{\circ}3$
1820, January 1st	$37^{\circ}3$	$19^{\circ}9$	$17^{\circ}4$
" " 13th	$36^{\circ}2$	$18^{\circ}7$	$17^{\circ}5$
" " 15th	$36^{\circ}4$	$14^{\circ}6$	$21^{\circ}8$
1823, " 19th	$36^{\circ}9$	$13^{\circ}4$	$23^{\circ}5$
1826, " 14th	$36^{\circ}3$	$19^{\circ}5$	$16^{\circ}8$
" " 15th	$36^{\circ}4$	$18^{\circ}4$	$18^{\circ}0$
" " 16th	$36^{\circ}5$	$18^{\circ}9$	$17^{\circ}6$
1830, " 18th	$36^{\circ}7$	$18^{\circ}1$	$18^{\circ}6$
" " 31st	$37^{\circ}9$	$20^{\circ}0$	$17^{\circ}9$
" February 2nd	$37^{\circ}7$	$17^{\circ}0$	$20^{\circ}7$
" " 3rd	$37^{\circ}8$	$19^{\circ}2$	$18^{\circ}6$
" " 5th	$38^{\circ}3$	$19^{\circ}0$	$19^{\circ}3$
" " 6th	$38^{\circ}6$	$18^{\circ}7$	$19^{\circ}9$
" December 24th	$37^{\circ}8$	$18^{\circ}4$	$19^{\circ}4$
" " 25th	$37^{\circ}6$	$18^{\circ}6$	$19^{\circ}0$
1838, January 12th	$36^{\circ}1$	$16^{\circ}8$	$19^{\circ}3$
" " 15th	$36^{\circ}4$	$16^{\circ}2$	$20^{\circ}2$
" " 19th	$36^{\circ}9$	$17^{\circ}0$	$19^{\circ}9$
" " 20th	$37^{\circ}0$	$10^{\circ}7$	$26^{\circ}3$
1841, " 7th	$35^{\circ}8$	$17^{\circ}4$	$18^{\circ}4$
" " 8th	$35^{\circ}7$	$12^{\circ}8$	$22^{\circ}9$
" February 3rd	$37^{\circ}8$	$19^{\circ}2$	$18^{\circ}6$
1845, " 12th	$38^{\circ}4$	$19^{\circ}2$	$19^{\circ}2$
1855, December 21st	$38^{\circ}8$	$20^{\circ}2$	$18^{\circ}6$
1860, " 25th	$37^{\circ}6$	$20^{\circ}2$	$17^{\circ}4$
1867, January 4th	$36^{\circ}4$	$13^{\circ}2$	$23^{\circ}2$
" " 14th	$36^{\circ}3$	$19^{\circ}3$	$17^{\circ}0$
1870, December 25th	$37^{\circ}6$	$20^{\circ}6$	$17^{\circ}0$

On the 26th of December the temperature remained below the average and continued so till January 5th, 1871; the 6th and 7th were several degrees warmer, the temperature on each of these days being somewhat above the average; on the 8th, however, the frost returned, and although the weather was not nearly so cold as at the end of December, the following five days' temperature was several degrees below the average, thus showing a period of twenty-four days of continued cold weather. The following list gives the periods of six days or more when the cold, during the years 1814–70, has been of unusual extent:—

TABLE II.

Periods.	Number of Days' duration.	Temperatures.		Mean Daily departure below the average Temperature during the Period.
		Average of Fifty Years.	Of the Period.	
1814, January 1 to January 25	25	36.6	25.9	10.7
" February 20 to February 27	8	39.3	26.5	12.8
" December 19 to December 27	9	38.2	27.4	10.8
1815, January 3 to January 9	7	36.1	30.9	5.2
" " 19 " 27	9	37.6	27.3	10.3
1816, February 7 to February 13	7	38.7	23.7	15.0
1818, " 2 " 15	14	38.4	30.5	7.9
1819, December 8 to December 14	7	40.9	27.0	13.9
" " 24 to 1820, January 18	26	36.7	26.6	10.1
1820, February 15 to February 21	7	38.4	29.3	9.1
" " 26 to March 10	14	40.2	30.9	9.3
" December 25 to 1821, January 5	12	37.1	28.0	9.1
1822, " " 1823, " 1	8	37.4	27.1	10.3
1823, January 9 to January 26	18	36.8	25.2	11.6
1826, " 8 " 17	10	36.2	23.5	12.7
1827, " 19 " 27	9	37.6	27.2	10.4
" February 8 to February 20	13	38.5	28.8	9.7
1829, January 16 to January 25	10	37.2	24.8	12.4
" December 21 to 1830, January 2	13	37.6	27.4	10.2
1830, January 12 to January 19	8	36.5	25.6	10.9
" " 29 to February 6	9	38.1	22.9	15.2
1835, December 20 to December 26	7	38.2	26.2	12.0
1836, " 25 " 31	7	37.4	29.1	8.3
1838, January 8 to January 28	21	36.9	23.6	13.3
" February 1 to February 6	6	38.0	29.0	9.0
" " 10 " 17	8	38.3	28.3	10.0
1839, January 27 " 2	7	38.1	29.7	8.4
1840, February 19 " 24	6	38.9	29.6	9.3
" December 22 to December 30	9	37.6	27.4	10.2

TABLE II. (*continued.*)

Periods.	Number of Days' duration.	Temperatures.		Mean Daily departure below the average Temperature during the Period.
		Average of Fifty Years.	Of the Period.	
1841, January 3 to January 10.....	8	36.1	23.9	12.2
" February 1 to February 10	10	38.5	24.9	13.6
1844, December 5 to December 14	10	41.3	28.1	13.2
1845, February 7 to February 13.....	7	38.6	26.9	11.7
1846, December 11 to December 18.....	8	40.2	27.8	12.4
" " 25 to 1847, January 2	9	37.3	29.4	8.0
1847, February 7 to February 13.....	7	38.6	26.0	12.6
1848, January 20 to January 28	9	37.8	28.7	9.1
1850, " 6 " 16	11	36.1	29.4	6.7
1853, February 12 to February 21	10	38.4	30.2	8.2
" December 25 to 1854 January 4....	11	37.2	28.1	9.1
1855, January 17 to January 23	7	37.1	26.1	11.0
" February 7 to February 23.....	17	38.6	26.0	12.6
1857, January 28 " 5.....	9	38.0	28.9	9.1
1859, December 14 to December 20.....	7	39.8	25.7	14.1
1860, " 18 " 29.....	12	38.2	27.7	10.5
1861, January 2 to January 11	10	36.1	26.3	9.8
1867, " 12 " 22	11	36.7	26.4	10.3
1870, December 21 to 1871, January 5	16	37.4	26.2	11.2
" " " " 13	24	36.9	28.6	8.3

Thus in the fifty-seven years ending 1870, there have been but two periods of longer duration of cold weather, viz. 1814, January 1, to January 25, and 1819, December 24, to January 18, 1820; going back to 1771, however, we have several mentions of severe and long-continued frost, thus:—

In 1774, "The year began with severe frost, and for nearly *two months* the ground was frost-bound."

In 1780, "This year began with a frost almost as severe as that in 1772 the weather continued severe till near the end of February."

In 1784, "There was steady frost with snow till February 21."

In 1785, "On the last day of January a very severe frost set in and continued till the middle of March."

In 1795, "The frost began about the middle of December (1794), was excessively severe in January (mean temperature of the month $23^{\circ}9$), and continued till the end of March."

From these notes it would appear that the winters at the latter end of the last century were much colder than any during the last thirty years.

The degree of cold during the period was not nearly so severe as has been experienced on many similar, although shorter periods, as will be seen by reference to Table II. The coldest part of the period, viz. the four days December 22, 23, 24, and 25, was very remarkable, the mean temperature of these days being $22^{\circ}6$. The following are all the instances of consecutive four days of lower temperature during the fifty-six years 1814-70:—

1814, January	10th-13th,	the mean temperature was	$22^{\circ}2$
1816, February	7th-10th	" " "	$20^{\circ}9$
1820, January	12th-15th	" " "	$19^{\circ}5$
1826, "	18th-16th	" " "	$19^{\circ}9$
1829, "	22nd-25th	" " "	$22^{\circ}5$
1830, "	16th-19th	" " "	$22^{\circ}4$
" February	2nd-5th	" " "	$20^{\circ}2$
1838, January	12th-15th	" " "	$19^{\circ}1$
" "	18th-21st	" " "	$18^{\circ}3$
1841, "	7th-10th	" " "	$18^{\circ}9$
1867, "	2nd-5th	" " "	$20^{\circ}6$
1870, December	22nd-25th	" " "	$22^{\circ}6$

Thus there are no instances of lower mean temperature of four consecutive days during the month of December in the years 1814-70 than those of the year 1870.

XXVI. *Meteorological Observations in 1869, at Martendale, Southland, New Zealand, lat. 46° 17' S., long. 168° 20' E., height above sea-level 79 feet, distance from sea 10 miles.* By C. ROUS MAREX, F.M.S., Director of Meteorological Stations.

1869.	Barometer (at 32° and sea-level).			Thermometer (in shade).							Radiation.		Hygro- meter.			Rainfall.			Cloud.		Wind.							Anemo- meter.	Other ob- servations.										
	Minimum.		Mean.	Range.	Mean of Maximum.	Mean of Minimum.	Mean Tempe- rature.	Mean Daily range.	Maximum in Month.	Minimum in Month.	Extreme range.	Solar.		Terrestrial.		Ratio force of Vapour. (100-).	Nr. of Days Rain fell.	Total Amount in. 24 hours.	Evaporation Total Amount in.	Cloud.	Mean	Ozone. Amount.	Wind.																
	in.	in.										Mean.	Maximum.	Mean.	Minimum.								N.W.	W.	S.W.	S.	E.S.			E.	N.E.	N.							
January	30.715	29.962	29.808	1.213	48.3	58.3	26.0	82.2	38.0	44.2	139.4	150.0	39.3	24.0	48.7	34.7	71	11	3.24	1.01	4.64	4.3	5.7	1	6.10	0	7	6	•	•	0	0	1	3	0				
February	44.2	29.280	94.3	1.102	49.0	48.4	58.7	20.6	80.5	36.0	44.8	131.8	148.0	38.2	27.0	48.9	34.8	71	5	2.36	1.02	2.49	4.1	6.1	1	0.115	0	6	5	•	•	0	0	0	1	0			
March	284	311	864	0.973	64.9	44.9	54.9	20.0	80.0	34.0	45.0	122.9	140.0	38.7	29.0	47.0	33.4	74	13	5.67	1.22	4.14	5.6	6.2	0	1	0	0.12	17.236	680	0	3	0	4	0				
April	377	29.908	958	1.074	58.1	43.3	50.7	14.8	70.0	31.0	39.0	99.8	127.0	35.3	22.0	46.7	31.7	87	20	2.64	0.43	1.38	6.6	6.4	4	0	3	6	2	0	6	9	105	410	0	1	1		
May	303	29.981	715	1.342	48.3	36.8	42.6	11.6	57.0	25.0	32.0	89.8	108.0	29.0	18.0	40.4	25.1	92	20	7.13	1.14	0.12	7.3	5.8	5	0	1	4	0	0.15	6.147	685	1	2	2	3	4		
June	305	29.190	920	1.115	49.7	34.1	41.9	15.6	56.0	23.0	38.0	89.6	101.0	26.2	14.0	37.9	23.1	86	16	3.29	0.76	1.99	5.1	5.4	3	1	5	3	0	1	4	13	175	705	0	2	1	2	
July	224	341	970	0.883	50.8	35.2	43.0	15.6	60.0	26.0	34.0	89.6	104.0	26.7	16.0	38.6	23.4	84	18	4.33	0.64	1.13	5.4	5.9	3	0	1	0	2.14	10	163	680	0	3	0	8			
August	182	303	912	0.878	53.8	37.2	46.5	18.6	66.0	24.0	45.0	106.4	124.0	26.6	13.0	42.3	27.0	86	10	2.98	0.77	1.72	4.9	5.4	8	1	2	0	1	7	10	185	510	1	2	1	7		
September	270	301	815	1.000	58.1	40.3	49.2	17.8	72.0	30.0	42.0	•	•	29.8	19.0	43.6	28.4	81	14	3.08	0.58	2.00	5.2	4.5	5	0	3	0	0.12	6.285	560	0	4	0	4	1			
October	301	214	834	1.087	60.6	40.8	50.7	19.8	72.0	36.0	46.0	•	•	31.1	16.0	43.5	28.3	78	10	2.78	0.84	2.60	5.5	4.9	5	0	2	8	1	5	9	283	520	0	1	0	3		
November	344	151	734	1.083	63.8	41.5	52.7	22.2	72.0	30.0	42.0	•	•	34.2	23.0	41.2	33.9	82	10	3.39	0.63	2.67	5.4	5.0	1	0	0.19	0	5	5	140	310	0	1	0	2	2		
December	30.355	29.608	29.957	0.747	75.3	49.5	62.4	25.8	86.0	29.0	57.0	145.1	163.0	41.2	21.0	55.5	43.9	78	9	1.59	0.42	5.74	4.7	7.6	0	0	0.20	0	0	11	103	220	0	0	4	2			
Year	30.442	29.981	29.844	1.481	60.3	41.7	51.0	18.6	86.0	24.0	62.0	111.6	163.0	39.9	13.0	44.5	30.4	79	156	42.68	1.22	30.32	5.3	5.7	36	3	26	92	3	5	93	107	180	705	2	19	5	23	40

General Remarks.—GALZES: January 3 and 4 (E. and N.W.), March 21st to 26th (W. and N.W.), May 3rd to 9th (W.), June 14th and 16th (W.), August 10th and 11th (N.W. and W.), September 21st, 28th, 29th (W.), October 12th and 13th (S.E.).

EARTHQUAKES: January 14th, June 24th, and December 28th (sharp). February 10th and October 17th (slight). Severe thunderstorm on December 17th. Heavy snowstorm on May 7th. Very few aurora or meteors seen. Zodiacal light particularly bright.

* Instruments out of order.

At the Bluff-Hill signal-station (lat. 46° 36' 55" S., long. 168° 21' 35" E., elevation 869 feet) the mean pressure was 29.903 inches, and the barometric range 1.470 inch (reduced); mean temperature of the air 49° 8'; mean daily range 9°; maximum temperature in shade 78°; minimum temperature 32°; total rainfall 64.87 inches on 184 days; maximum fall of rain in day 2.07 inches; mean amount of cloud 69; wind N. 9 days, N.E. 40, E. 36, S.E. 93, S. 18, S.W. 83, W. 56, N.W. 66 days; snow on 3 days; hail 31; fog 82; thunder 9; frost 1 day. Ozone in December 67.

TABLE showing the Rainfall at the Meteorological Observatory, Martendale, Southland, New Zealand.

Months.	Monthly Rainfall.											
	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.
January ...	in. ...	in. 0'69	in. 2'77	in. 0'31	in. 5'52	in. 2'31	in. 3'89	in. 10'04	in. 6'87	in. 5'09	in. 5'30	in. 3'24
February ...	... ..	... 2'21	... 0'32	... 0'56	... 2'80	... 2'73	... 8'14	... 2'73	... 5'58	... 3'46	... 3'54	... 2'36
March.....	... ..	... 2'83	... 2'42	... 4'34	... 2'98	... 5'20	... 5'45	... 3'65	... 4'42	... 2'36	... 3'09	... 5'67
April .....	... ..	... 5'96	... 0'40	... 4'78	... 0'59	... 6'05	... 3'95	... 5'07	... 4'52	... 1'55	... 4'04	... 2'84
May .....	... ..	... 2'10	... 6'24	... 0'01	... 5'40	... 3'97	... 9'92	... 6'02	... 2'17	... 4'59	... 3'92	... 7'13
June .....	... ..	... 2'45	... 1'09	... 5'62	... 8'76	... 4'39	... 7'00	... 5'86	... 5'54	... 1'67	... 3'67	... 3'29
July .....	... ..	... 0'21	... 4'30	... 0'83	... 0'77	... 8'41	... 0'61	... 3'09	... 2'47	... 3'49	... 4'39	... 4'33
August .....	... ..	... 1'79	... 8'92	... 2'19	... 2'25	... 7'17	... 1'71	... 6'68	... 4'48	... 5'63	... 4'23	... 2'98
September ...	4'02	1'91	0'19	0'98	1'60	4'35	4'12	4'08	1'53	1'73	0'77	3'08
October	4'47	0'47	0'94	0'76	5'07	5'29	0'85	6'19	2'95	4'80	3'50	2'78
November ...	2'82	0'52	1'35	0'95	3'92	4'44	1'99	8'48	2'90	6'21	4'83	3'39
December ...	2'56	1'58	0'28	6'17	7'61	3'69	3'37	1'80	3'86	1'98	5'05	1'59
Sums	...	22'72	29'12	27'50	47'27	58'00	51'00	63'69	47'29	41'56	46'33	42'68

TABLE showing the Mean Temperature of each Month during the Years 1858-69 at the Meteorological Observatory, Martendale, Southland, New Zealand.

Months.	Mean Monthly Temperature.											
	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.
January	0	66.4	63.8	65.4	61.9	61.4	58.9	58.1	57.3	55.8	54.6	58.3
February	...	62.2	60.1	67.6	62.4	58.4	57.8	60.1	58.1	55.9	55.4	58.7
March	...	58.6	60.2	60.6	57.9	55.2	53.4	55.2	53.1	51.8	53.9	54.9
April	...	54.2	55.5	54.5	48.2	46.5	52.5	50.7	49.1	52.4	51.7	50.7
May	...	49.4	51.2	48.5	44.5	41.6	46.6	46.2	46.7	48.3	46.3	42.6
June	...	43.1	39.2	43.9	41.2	38.0	42.8	45.1	44.1	41.8	39.0	41.9
July	...	39.3	42.3	40.4	34.1	42.6	41.4	43.2	40.4	43.6	43.7	43.0
August	...	42.0	44.0	43.9	41.3	44.1	42.5	42.6	47.3	44.0	40.9	46.5
September ...	48.5	49.7	51.0	53.2	50.1	52.7	49.3	47.0	47.4	49.1	46.2	49.2
October	54.7	56.9	57.0	54.5	53.8	50.1	52.2	48.2	51.6	49.9	49.5	50.7
November ...	58.3	60.0	61.1	56.5	59.2	56.0	54.1	52.7	53.0	50.3	53.6	52.7
December.....	65.8	61.3	67.6	62.6	59.3	57.3	59.7	61.6	53.8	55.2	53.0	62.4
Mean	...	53.6	54.4	54.3	51.2	50.4	52.0	50.9	50.7	49.8	49.0	51.0

TABLE showing the Monthly Range of Temperature as deduced from the observations taken at the Meteorological Observatory, Martindale, Southland, New Zealand.

Months.	Monthly Range.											
	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.
January	°	49°	41°	°	40°	46°	39°	°	51°	°	53°	°
February ..	...	49°	48°	52°	46°	62°	40°	42°	44°	47°	46°	44°
March.....	...	45°	51°	46°	47°	46°	44°	39°	49°	46°	40°	46°
April	...	39°	53°	57°	39°	45°	40°	45°	42°	46°	35°	39°
May	...	38°	39°	45°	48°	48°	32°	31°	45°	44°	40°	32°
June	...	39°	44°	42°	38°	43°	38°	30°	41°	33°	37°	33°
July	...	47°	43°	34°	43°	32°	45°	33°	42°	38°	36°	34°
August	...	43°	37°	40°	40°	34°	43°	38°	38°	43°	44°	45°
September ...	36°	44°	47°	44°	42°	46°	40°	40°	47°	45°	42°	42°
October	38°	40°	42°	54°	40°	40°	45°	39°	49°	36°	34°	46°
November ...	46°	43°	40°	63°	35°	42°	38°	47°	45°	40°	28°	42°
December ...	56°	45°	50°	47°	40°	44°	48°	50°	50°	39°	40°	57°
Range in year	...	80°	81°	74°	75°	73°	66°	59°	65°	62°	60°	62°

TABLE showing the Prevailing Direction of Wind during each Month of the Years 1858-69 as deduced from the observations taken at the Meteorological Observatory, Martendale, Southland, New Zealand.

Month.	Monthly Direction of the Wind.											
	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.
January	N.W., S.E., E.	N.W., S.E., W.	N.W., S.E., W.	S.E.	N.W., S.E., W.	W., N.W.	N.W.	S.E., W., N.W.	N.W., S.E., W.	S.E., W.	S.E., W., N.W.	S.E., W., N.W.
February	N.W., W.	N.W., W.	W.	S.E., N.W., W.	N.W., S.E., W.	S.E., N.W.	S.E., W.	S.E., N.W.	W., N.W.	N.W., W.	S.E., W.	S.E., N.W.
March	W.	W.	N.W., S.E., W.	N.W., W.	N.W., S.E.	N.W., W.	N.W., S.E., W.	N.W., S.E., W.	N.W., S.E., W.	W., S.E., W.	W., N.W.	W., N.W.
April	N.W., W.	N.W., W.	N.W., W.	N.W., S.E., W.	N.W., S.E., W.	N.W., W.	S.E., W.	N.W., S.E.	W., N.W.	W., N.W.	W., N.W.	S.E., W., N.W.
May	N.W., W.	N.W., W.	N.W.	N.W., E.	N.W., W.	N.W., S.E., W.	N.W., W.	N.W., N.W.	W., N.W.	W., N.W.	W., N.W.	W., N.W.
June	N.W.	N.W.	N.W., S.E.	N.W., S.E., W.	N.W., W.	N.W., S.E., W.	N.W., W.	W., N.W.	W., N.W.	S.E., N.W., W.	S.E., N.W.	S.E., N.W.
July	N.W., E., W.	N.W., E., W.	N.W., S.E., E.	N.W., E.	N.W.	E., N.W., W.	N.W., E.	N.W.	E., N.W.	W., N.W.	W., N.W.	W., N.W.
August	N.W., E., W.	N.W., E., W.	N.W., W.	N.W., W.	N.W., E., W.	N.W., S.E., W.	N.W., S.E., W.	N.W.	W., N.W.	W.	S.E., N.W., W.	S.E., N.W.
September	N.W., S.E., W.	N.W., S.E., W.	N.W., E., W.	N.W., S.E.	N.W., S.E., W.	N.W., W.	N.W., S.E., W.	S.E., W., N.W.	N.W., S.E., W.	S.E.	S.E., W.	S.E., N.W.
October	N.W., S.E., W.	N.W., S.E.	N.W., S.E.	N.W., S.E., W.	N.W., W.	N.W., S.E., W.	S.E., E.	W., N.W.	W., S.E., N.W.	W., S.E.	W., N.W.	S.E., N.W.
November	S.E., W.	N.W., W.	S.E., E., W.	N.W., S.E., W.	N.W., S.E., W.	N.W., S.E.	N.W., S.E., W.	W., N.W.	N.W., S.E., W.	W.	S.E., N.W., W.	S.E.
December	N.W., S.E., W.	N.W., S.E., W.	S.E., W.	N.W., S.E.	N.W., S.E., W.	N.W., S.E., W.	S.E., W.	S.E., W., N.W.	S.E., W., N.W.	S.E., W., N.W.	S.E., W.	S.E., N.W.

XXVII. *Description and Figure of Mr. Cator's Anemometer as arranged with Spiral Apparatus.*

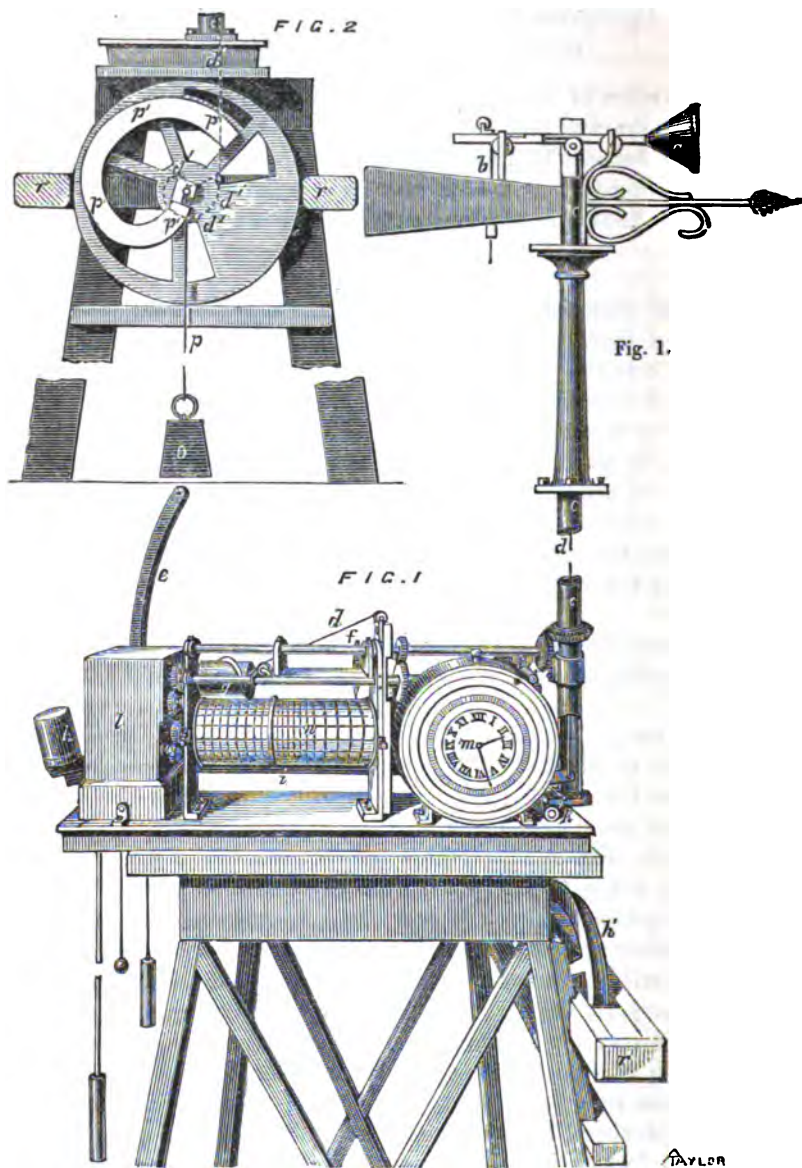
A DESCRIPTION of his anemometer, as fitted up with the double-curved levers, was read as a paper by Mr. Glaisher before this Society on January 17, 1866; and a short paper, giving an account of its working for two months after its erection at Beckenham in September 1867, was also read at the November Meeting of that year.

Another plan for measuring the strength of the wind having about that time suggested itself to him, he devised the means of applying it to the instrument, and accordingly had it fitted up,—not intended as an improvement upon the levers, which may or may not be the case, and remains to be seen, but merely as it seemed to be worth a trial, it being so easy to apply it to the instrument by disconnecting the levers and connecting *it* instead. This new application is a system of double spirals, a description of which was read before the Society at the February Meeting in 1869, with a few particulars of the records produced.

The description is here repeated, for the sake of reference to the accompanying figure. .

The other parts of the instrument being explained at length in the paper of January 1866, above referred to, this notice is limited to the spirals. Fig. 1 shows such other parts, with the addition of the spiral-apparatus (*h'*), and the support (*r*) to which it is fixed. Fig. 2 shows the spiral-apparatus in detail. The spirals or snails (*p'p'...*, *d'd'...*) are concentric and rigidly connected together with each other and with a horizontal rod passing through their centres, and revolve, with such rod as their common axis, in vertical planes side by side, the horizontal rod resting on strong supports (*r*) at each end of it. The two spirals are of different sizes; the perimeter (*d'*) of the smaller one is equal to the length of the scale of pounds on the recording-sheet (*n*), and also to the total space through which the pressure-plate (*a*) is moved, viz. about 5 inches; and round this is wound a chain (*d*) one end of which is rigidly fastened to the rod at its centre, and the other to the steel wire (*d*) which comes down from the bar

Cator's Anemometer with spiral-arrangement.



connected with the pressure-plate; and it is so adjusted that when it is calm (fig. 2 showing their position in a state of calm) the chain is wound wholly round this spiral, and leaves it as a tangent at the point furthest from its centre, viz. about 2 inches; and as the pressure-plate is moved forward by the wind, the steel wire (d) is lifted up, and so unwinds the chain (d') from the spiral and causes it to leave the spiral as a tangent, accordingly, at a point nearer to its centre. The other spiral (p') is of much larger size; and round its perimeter is wound a string (p), to one end of which is fastened the horizontal rod which passes through its centre, and to the other a weight (o), which is adapted to the size of this spiral: it is so arranged that, when it is calm, no part of the string is wrapped round this spiral, but it merely hangs direct from, or is a tangent to, the curve at its centre; and as the pressure-plate is moved forward by the wind, this spiral (being rigidly connected with the other one) is made to revolve, and the string (p) to be wrapped round it, leaving it as a tangent, accordingly, at a distance from its centre.

From the above it will be readily seen that the two spirals are moved through equal angles, and act reversely (or with opposite intensity), the small one being unwound while the large one is being wound, the tangential chain (d) of the small one nearing the centre as the tangential string (p) of the large one becomes at the same time further from it; and so the effect is doubled. The apparatus may be regarded as a continual series of levers, the actual and relative lengths of the two arms from the fulcrum being gradually altered as it is made to revolve: in the first instance, a very small force applied at the pressure-plate, or, which is the same thing, at the end of the chain, will cause the apparatus to revolve, and will lift the fixed weight (o) hanging from the centre or fulcrum; and power will always be gained, or, in other words, the pressure of wind will always be less than the fixed weight, till it has revolved through such an angle that the chain (d) and string (p) are at the same length of arm from the centre; and as it revolves further round, the pressure of the wind, so causing the chain to act at a shorter and shorter arm or nearer and nearer to the centre, will be always proportionately greater than the fixed weight, which will act at a longer and longer arm, or further and further from the centre. The string which carries the recording-pencil (f) to and fro is fastened to the steel wire

(d) at a short distance above the chain belonging to the small spiral.

One great advantage may here be mentioned, viz. that the spiral-apparatus can be very readily disconnected, and the levers again applied, or *vice versa*, at pleasure. This is now the third winter that this system has been at work, and it has proved entirely satisfactory.

CORRESPONDENCE, &c.

On a Cyclonic Storm. Extract from a Letter from A. V. NURSING RAO to W. HUGGINS, Esq., D.C.L., F.R.S.

Vizagapatam, Data Gardens,
November 18, 1870.

MY DEAR SIR,—We had a violent cyclonic storm on the night of the 4th instant, between 11^h P.M. and 6^h A.M. of the following morning.

The roofs of some of the buildings were demolished, and the largest trees were torn up by the roots. The heavy branches were blown to distances ranging between 20 and 40 yards, and the roads are filled with ruined trees. Some of the houses were so greatly damaged that the tenants were obliged to leave them.

Really a melancholy scene everywhere in Vizagapatam and its suburbs. Almost all the trees of the cocoa-nut topes and the orchards, that Vizagapatam was once so proud of, were prostrated.

Suspicious of storm arose at 2^h 30^m P.M. of the 4th, when my observer reported a fall of the barometer of 0.142 in. The last observation of the barometric condition made by me was at 0^h 30^m P.M., it being then 29.800 in. The space of time between the two observations being two hours, and as we were not able to judge within what space of time the fall actually took place, we were obliged to wait with close watch for another change up to 9 P.M.

The reading of the barometer remained at 29.658 in., without variation between 2^h 30^m P.M. and 9^h P.M., a N.W. wind pre-

vailing, which brought on some clouds from the north, with light showers off and on, between 2^h and 4^h P.M. The rain was, after all, 0.2 in. only. From 4^h P.M. the force of the wind decreased. Before 11 o'clock the wind veered to N.E. with very strong currents; the aspect of the sky was then very stormy. The decrease in the reading of the barometer from 11^h to 12^h P.M. was 0.146 in. from 29.640 in. which was registered at 10^h P.M. At 12^h 20^m it was 29.440 in., at 1^h A.M. 29.404 in., at 1^h 30^m it was 29.340 in., at 2^h A.M. 29.260 in., at 2^h 30^m it was 29.124 in., at 3^h A.M. 28.960 in., and at 3^h 30^m the reading was 28.800 in. From this continued fall, and the wind keeping in the same quarter up to the lull of the cyclone, but increasing in violence, one would be induced to think that we were situated very close to the centre of the cyclone.

The intensity of the cyclone was felt from a little before 2^h to 3^h 50^m A.M. In the interim, at 2^h 30^m, a lull was observed, and great hopes were entertained of entire cessation; but within 10 minutes it raged again very furiously, with S.E. wind.

It will be observed from the figures given in paragraph five, that the fall between 2^h and 3^h A.M. was $\frac{1}{10}$ in., which fall of mercurial column in one hour, I believe, is not common.

The Thermometric condition.—The reading of the dry bulb at 10^h P.M. of the 4th was 81°·4, and of the wet bulb 72°·5; at 1^h A.M. dry 77°·1, wet 72°·5; and at 2^h A.M. dry 78°, wet 73°. At 2^h and 2^h 45^m, the violence of the wind was so great that doors were smashed, and some of the walls of the upper rooms of the house were prostrated, and we were afraid that the house would be down upon us. However, the observations of the barometer, and the notes of the appearances of the sky were steadily continued.

The *Barometric* reading commenced to increase from 4^h A.M., when it was 28.860 in., and while the violence of the cyclone prevailed rose as steadily with S. and S.W. winds as it had previously fallen with N.E. and S.E. winds. The thermometric condition at 4^h A.M. were:—dry bulb 77°·9, wet bulb 74°. Direction of wind unsettled, S.E., S., and S.W.

Anemometer observations.—At 10^h P.M., 4th, the reading of the anemometer was registered, 441.50 miles; at 11^h P.M., 451.50 miles; at 2^h 30^m A.M., 650.05 miles; at 4^h, 850.55 miles. The wind apparently travelled 899 miles in five hours, and the average rate of motion was 79.81 miles per hour; but, owing to the intensity of the cyclone, it will be observed from the foregoing

figures that the rate of motion in one hour greatly exceeded 100 miles. This, of course, is distinct from the velocity of the progress of the cyclone.

Fifteen minutes after 4^h A.M., the bar of the anemometer, holding the hemispherical cups, was seen bent, and one of the four cups blown off; we were therefore deprived of the means of registering the velocity after this time. The decrease of the violence was, to a certain degree, sensible at 4^h 30^m A.M. The duration of the intensity was nearly three hours, and that of the cyclone itself was seven hours. Therefore the progress of the cyclone we can safely calculate at 28 miles per hour, and the diameter to be 140 miles.



BAILEY'S PUBLIC CLOCKS.

J. BAILEY and Co. manufacture Clocks of a most superior description by steam-power at very reasonable prices.

Extracts from Testimonials for Bailey's Tower-Clocks.

Testimonial from the Right Hon. the EARL OF ROSS, P.R.S., F.R.A.S., &c.

The Castle, Portsmouth, Ireland, March 22, 1860.

I beg to say that the Church Clock here exceeds every other. I believe never surpassed before.

Bank Field, Halifax, October 27, 1860.

I have much pleasure in stating that the Clock constructed by Mr. Bailey has met with my entire approval.

Hayle Foundry, Hunt Street, Oxford Street, Manchester, Feb. 25, 1861.

We have great pleasure in expressing our high appreciation of the industry and skill which fulfilled your contract for the large night-day Clock manufactured by you for the Church-House erected by our firm for the Poor of Felling, Penn. in March 1861. It has been everywhere satisfactory to the authorities and there. You are at liberty to publish any use you like of this Testimonial.

EDWARD BELLEFLORE and Co.

Springfield Works, Bedford, near Northampton, Feb. 21, 1861.

I am happy to be able to speak very highly of the Tower Clock you made for me nearly three years ago. It runs well, and has been only improved during that time. If it would be of any service to you, I HAVE NO DOUBT HAVE THE DISADVANTAGE OF THAT VERY IMPORTANT VILLAGE WITHIN A FEW FEET OF THE FACTORY. For with the illustration there it has been a public boon.

W. A. BELLEFLORE

William House, Avon Street, near Rastbury, May 24, 1861.

I have made inquiry about the Clock you made and find the main the Cathedral Church Tower of this place, in the spring of 1860, and I have much pleasure in telling you that it runs remarkably well, and gives universal satisfaction.

THOMAS C. CROFT

From the late RICHARD ROBERTS, the southern division.

Chichester Works, Southdown Street, Feb. 27, 1861.

I have great pleasure in stating that I have seen Clocks made by Mr. Bailey, which for WORKMANSHIP AND FINISH, I THINK SUPERIOR TO ANY I HAVE SEEN BY OTHER MACHINES. I consider Mr. Bailey's charges very moderate. I am of opinion that nothing the wheels and bearings of cast-iron is a great advantage, as it reduces the friction and is more durable than brass.

RICHARD ROBERTS, F.R.S., &c.

Fakenham Norfolk, Nov. 25, 1861.

I am happy to inform you that the Clock here strikes every time. It is quite a benefit to the inhabitants of Fakenham and the vicinity.

WM. LAWRENCE

Watchmaker and Jeweller.

Copy of letter received from the Right Hon. the EARL RUSSELL, Manchester.

Moulthill Hall, Manchester, Dec. 11, 1860.

My attention was first drawn to your Manufactory by the general report in your papers which I found to exist in Manchester, on my inquiries into what nature the proposed public Clock could safely be entrusted. Had any doubts existed in my mind, Lord Russell's testimony would have at once resolved them. I do not believe a more complete work can be found anywhere in the United Kingdom. The Clock put up by you at Felling-Horton, Mersey, is justly esteemed a great improvement to the place, and has, I believe, given universal satisfaction. Wishing you success in your laudable efforts to improve a useful public advantage, and more especially for the attempt to popularize accuracy in the lecture, which I read with pleasure.

J. P. MANCHESTER

At a MEETING OF THE STAINLAND PUBLIC CLOCK COMMITTEE, held on the 18th day of June, 1860, it was the unanimous opinion that Messrs. BAILEY and Co., of the Chichester Clock-Works, Salford, Manchester, had fulfilled their contract for the erection of a Public Clock in the Tower of the Parish Church, Stainland, Yorkshire in a most creditable manner, and that the performance of the Clock and the superior workmanship displayed are highly creditable to the Messrs. BAILEY and Co., and will tend to confirm that high reputation which they enjoy as makers of this class of time-indicators.

Signed on behalf of the Committee.

ELY SUTCLIFFE, Chairman.
ELLY WALKER SHAW, Vice-Chairman.
THOS. F. LAWRENCE, Hon. Secretary.

MANUFACTORY: ALBION WORKS, SALFORD, LANCASHIRE.

One of the grandest acts that can be performed by a man of worth is to secure the erection of a Public Clock in his Parish Church.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, F.R.S., SECRETARY.

1871, FEBRUARY 15.

CONTENTS.

Communications made at the Ordinary Meeting:—

XXVIII. Influence of the Moon upon the amount of Rainfall.—John Cheetham Buxton, M.D.S., F.M.S. (Two Woodcuts) . . .	190
XXIX. On Professor Puy's New Classification of Clouds.—Halifax James Mann, M.D., F.R.S., F.R.G.S., F.M.S. &c.	170
XXX. The Aurora Australis of October 23 and 24, 1870.—Robert James Mann, M.D., F.R.S., &c.	281
XXXI. Mean Temperature of the Air at Osborne, Isle of Wight, as deduced from Observations taken during the Years 1858-69 (inclusive).—J. R. Mann	282
XXXII. Eclipse of the Sun, 1870, December 22, as observed at Collister. —Arthur Porten, F.M.S.	282
XXXIII. Meteorological Observations recorded in 1869 at the Adelaide Observatory, South Australia, lat. 34° 57' S., long. 138° 38' E., height above sea-level 140 feet.—Charles Todd, Observer . . .	284

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1871, March.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1871, FEBRUARY 15. [No. 53.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Freeland, John, 1 *Gray's-Inn Square, London, W.C.* ;
Hall, John James, *Fulwell, Twickenham, S.W.* ;
Rowley, Edwin, 128 *St. James's Street, Brighton* ;
were balloted for and duly elected Fellows of the Society.

The names of Three Candidates for admission into the Society
were read.

XXVIII. *Influence of the Moon upon the amount of Rainfall.*
By JOHN CHARLTON BLOXAM, M.R.C.S., F.M.S.

HAVING ventured to suggest some explanation of the control exercised by the moon upon the fall of rain in a paper which was included in No. 47 of the 'Proceedings,' I propose now to put the statistics of that explanation in a more simple and concise form. It was submitted in the former paper that the moon's influence was dependent on three different conditions—namely, 1, the age of the moon ; 2, the length of time the moon remains above the horizon on each day of the lunation ; 3, the length of time the moon and the sun are together above the horizon on each of such days. It is my present purpose to show that these three elementary

agencies admit of being combined together arithmetically, so as to constitute one compound agent, the progression of which corresponds with that laid down for the rainfall. If this should be done satisfactorily, additional evidence, I think, will thereby be afforded that the explanation given was a sound one.

It will be convenient to name the first of these elementary causes A, the second B, and the third C. The daily numbers for B and for C are taken as they stand in Tables II. and III. in my former statement. These numbers have the advantage of not being made for the occasion; they were collected from the almanac without selection or modification. The compound agent sought for will be called x ; and in order to get the daily values for x , those for A must first be determined. There seems to be little room to doubt that the age of the moon does in some measure control the amount of rainfall; but the numerical value of this control is not to be found in the almanac. The weight of this condition as one elementary cause (the proportionate weight) must needs be discovered by experimental calculation.

It may be mentioned that I at first endeavoured to obtain x by the aid of a rule for modifying the values belonging to B and C, which was to be applied without variation to each of the thirty days; but after trying several formulæ, without obtaining a result that was satisfactory, I found that if the values for B and C were allowed to remain as they had been taken from the almanac, the numbers required to make up x then became such as appeared to be satisfactory values for A, irrespective of the purpose for which it was proposed to use them.

The values for B+C gave a single curve, the lowest point of which fell on day 15, the high values appearing at the extremities of the line; and it was then found that if the number 0.89 was used for the amount of the daily progression of A, this number was not high enough to convert the diminishing values of B+C on the early days of the lunation into increasing values, which it was necessary should be done in order to make them correspond with the values for rainfall; and it was found that if 0.9 was used, the values for B+C+A then increased to day 14, whilst the values for rainfall diminish after day 9 to day 15. No constant number, therefore, for the daily progression of A would answer the purpose; it was necessary to adopt a rule of progression which, though constant in itself, would give a varying quantity for each day's progress of this one agent—a rule that would

give a line ascending and descending conformably with that for the moon's light, but not varying at the same rate. The moon being on the average half a day old on day 0, the value for A on this day was taken to be 0.5. For day 1 the value was put at 1.5, and the additional amount due to each day's increase of age was then reduced each day by .08, as far as to day 14,—that is to say, the increase for day 2 became $1 - .08$, the value for day 2 thus being $1.5 + .97$, or 2.47. Day 15 was put at the same value as day 14, and the daily values were then reduced by the same amounts successively as had before been used for their increase. The values thus determined for A are inserted in Table I. These values, may be, do not represent the increment and decrement in the vaporizing power of the moon, as they certainly do not the degree of light reflected to the earth. The vaporizing power may, possibly, increase and decrease precisely as the moon grows and wanes; but, supposing the actual result as regards heat and vapour to vary precisely as the moon varies, it does not then follow that the result, as regards rainfall, will vary at the same rate. Atmospheric vapour tends to find its own level, as well as water, and its movements are constantly influenced by this tendency. Consequently, if there be a rapid increase of vapour effected by great moon-power, the vapour will then flow away laterally, under the law of gravity; and if, whilst this is going on, the values for B+C are very low, the vertical accumulation of vapour will never be very great, and, consequently, the fall of rain will not be great. It may, perhaps, be safest to regard the values adopted for A as merely the complementary amounts required to be added to B+C to obtain x ; but it does not seem improbable that they should be the actual proportional values proper to A as concerning the moon's influence upon the fall of rain under this head, viz. in respect to her age. The values given to A by this formula, of course, reach a maximum at the period of full moon; the values given to B, or rather by B, reach their maximum on day 10; those given by C have their maximum on day 0. $A+B+C$, which now $=x$, gives the maximum on day 10,—that is to say, one day later than that on which the maximum for rain is set down. There is the same discrepancy in the respective dates for the secondary maximum and the intermediate minimum; and the relative positions of the two lines accord with these discrepancies from day 8 to day 23. The diagram annexed gives the curves for rainfall in juxtaposition with those for x , and it may be seen that the two

lines are remarkably similar, notwithstanding the differences alluded to. The regularity and symmetry of these differences are such as to lead to the suspicion that these all arise from some one specific cause of derangement warranting the use of a correction. No cause has been discovered that fits to all; but one may be suggested that does apply to the greater number of them. The limits of the *day* for astronomical calculations are not the same as those commonly used for the registration of rainfall, the day being made to terminate, for this purpose, at three hours before noon. It is assumed that this mode of reckoning was used for the record under consideration. Supposing the influence of the moon upon the fall of rain to be such as has been represented, that period of the day in which the moon is below the horizon must be the period in which the fall of rain generally occurs. If so, there must be a date, or epoch, of maximum intensity of rainfall within the limits of this period. Let this epoch be taken to be at two hours before the rising of the moon; and let fig. 1 represent the rainfall-period, the hour of the moon's setting being at *a*, and that of her rising at *b*, and the epoch of maximum intensity at *c*; and let the shaded part of the figure represent the three-hours interval between 21^h and 24^h as this occurs on day 8. Fig. 2 will then represent the same particulars as they occur on day 9. It is evident that the shaded surface is larger in fig. 2 than it is in fig. 1, inasmuch as the width of the shaded part increases more from day to day on the right-hand side than it lessens on the left-hand side; consequently the rainfall is greater on day 9 than on day 8 during the three-hours interval.

Fig. 1.

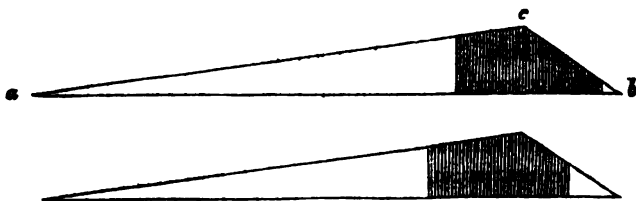


Fig. 2.

Now on day 8 the moon rises at 20^h 43^m; and, consequently, no part of the rainfall period comes within the three-hours interval. But on day 4 the moon rises at 21^h 35^m, thus giving thirty-five minutes of the rainfall-period to the three-hours interval, and

there will therefore be more rain in the three-hours interval on day 4 than on day 3; and this excess, instead of being given to the (astronomical) day 4, is given to day 3 in registering the rainfall. These thirty-five minutes account for the rainfall, as shown by the diagram, on day 3 being slightly greater than the value for x indicates. On day 5, one hour and twenty-three minutes of the rainfall-period come within the three-hours interval, instead of twenty-five minutes, as on day 4, and a considerable excess is accordingly indicated for day 4. The rainfall during the three-hours interval continues to increase daily (according to the present view of the matter) until day 11; and on day 11 the epoch of maximum intensity occurs at thirty-five minutes after noon, and the shaded surface, therefore, comes to be less on day 11 than on day 10; and the value for rain, as shown by the diagram, is below that for x on day 10. As the shaded part of the figure passes each day further towards the more acute angle of the figure, the rainfall during the three-hours interval diminishes each day, and the rainfall, as shown by the diagram, is in defect each day as far as to day 14. Passing, now, to day 19, the rainfall appears still to be in defect as compared with x , and it continues to be so down to day 23; and the whole of the rainfall-period passes beyond the limit of the three-hours interval on day 23, the moon setting after noon on this day; and she sets seven minutes before noon on day 22. The defect here ceases one day earlier, therefore, than in strictness it should do according to the theory. Of course this explanation goes for nothing if the astronomical day was, in fact, adhered to in this particular record. Independently of this consideration, however, the explanation does not quite cover the ground. Each of the four values 15–18, in the second ascending branch of the line x , ought to be above the line for rain instead of below it, in order to conform with the rule suggested. There is a separation of the lines, also, at the commencement of the lunation which the theory does not apply to in any way. This divergence arises from the value for x on day 1 showing a great rise, whilst the corresponding increment in the rainfall does not occur till day 2.

It was desirable to have the daily values for x expressed in such a form that they might be readily compared with those for the rainfall; they were therefore subjected to a smoothing process, and they were then altered in scale, so as to correspond with the scale of the rainfall values. The smoothing was effected by giving to

each day the sum of the values of its three nearest days, so that the value given to day 1 was the sum of the values proper to the days 0, 1, and 2. The *sum-values* obtained by this process gave a wider range than that given by the rainfall values as already laid down; the range or scale, therefore, had to be reduced. In order to effect this reduction, the number representing the maximum of rainfall was used to represent the maximum for s ; and the number representing the minimum of rainfall was used to represent the minimum for s . Then the reduction of each day's value was made to be proportionate to that of the whole range. Table II. gives, in column 1, the values for $A+B+C$, in column 2 the values for $A+B+C$ smoothed, and in column 3 the smoothed values reduced to the scale of the rainfall values. It is these last values, of column 3, that have been used for the drawing of the diagram. Under this arrangement the mean value for s is 44.74, that for the rainfall being 44.65.

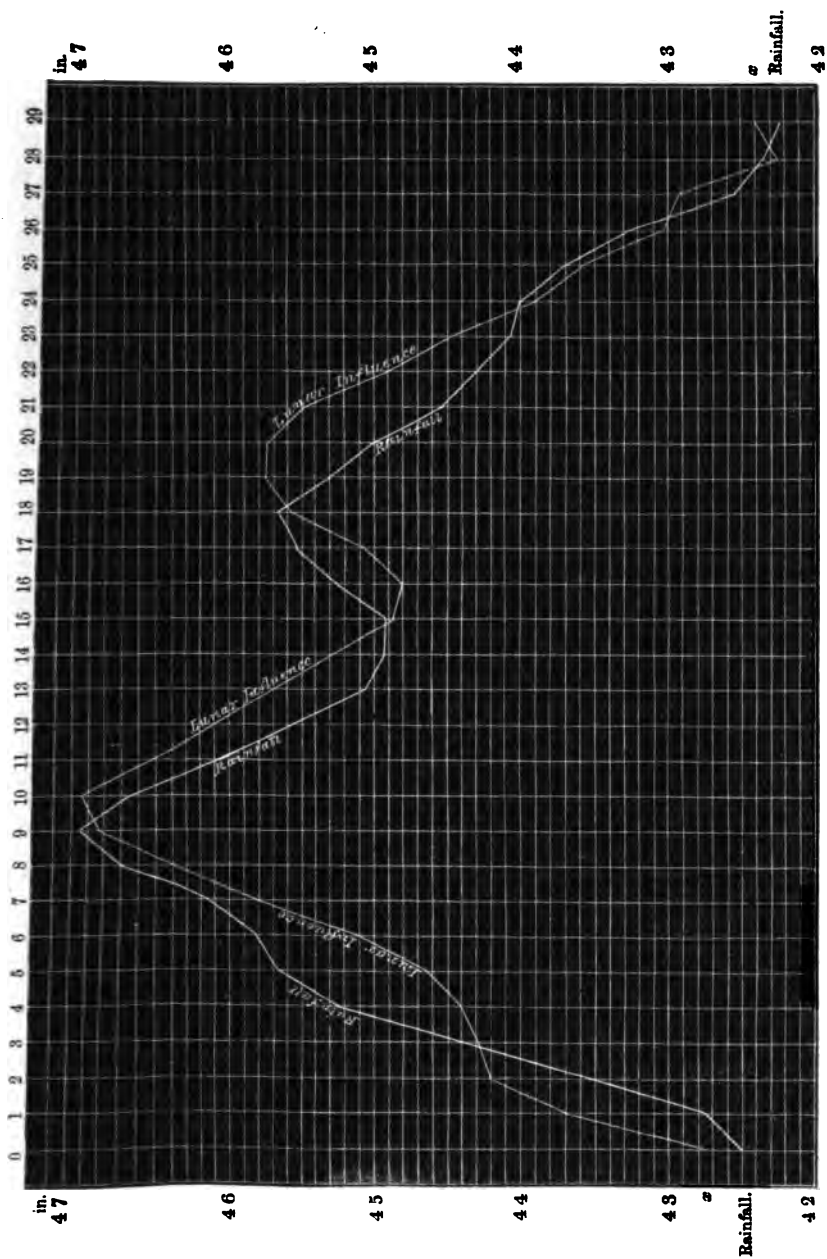
TABLE I.

Age of Moon.	Values for A.
0	0.50
1	1.50
2	2.47
3	3.41
4	4.32
5	5.20
6	6.05
7	6.87
8	7.66
9	8.42
10	9.15
11	9.85
12	10.52
13	11.16
14	11.77
15	11.77
16	11.16
17	10.52
18	9.85
19	9.15
20	8.42
21	7.66
22	6.87
23	6.05
24	5.20
25	4.32
26	3.41
27	2.47
28	1.50
29	0.50

TABLE II.

Age of Moon.	1. $A+B+C=s$.	2. s smoothed.	3. s reduced.
0	23.61	70.59	42.73
1	24.20	72.10	43.73
2	24.29	72.83	44.20
3	24.34	72.98	44.29
4	24.35	73.15	44.40
5	24.46	73.52	44.64
6	24.71	74.26	45.12
7	25.09	75.14	45.69
8	25.34	76.07	46.29
9	25.64	76.73	46.72
10	25.75	76.92	46.74
11	25.53	76.27	46.42
12	24.99	75.64	46.02
13	25.12	75.00	45.60
14	24.89	74.50	45.28
15	24.49	73.87	44.87
16	24.49	73.76	44.80
17	24.78	74.17	45.06
18	24.90	74.79	45.46
19	25.11	75.09	45.66
20	25.08	75.06	45.64
21	24.87	74.65	45.37
22	24.70	73.91	44.89
23	24.34	73.23	44.45
24	24.19	72.39	43.91
25	23.86	71.90	43.59
26	23.85	71.04	43.04
27	23.33	70.86	42.92
28	23.68	69.79	42.23
29	22.78	70.07	42.41

Diagram showing the amount of Rainfall in correlation with Lunar influence.



NOTE.—This diagram is drawn with the "amended values" for rain of the former communication.

XXIX. On Professor Poey's New Classification of Clouds.**By ROBERT JAMES MANN, M.D., F.R.A.S., F.R.G.S., F.M.S., &c.**

THE object of the author of this communication to the Meteorological Society is simply to draw the attention of English meteorologists to the chief practical points of the very important and interesting revolution in the nomenclature and classification of clouds that has recently been proposed by Professor Poey, of Havana.

The basis of Professor Poey's classification is, in the main, the division of clouds into the high snow- and ice-cloud and the low vesicular, or vapour-cloud; and the introduction of the great sheet-cloud of mid-region which dissolves into the cirrus and cumulus forms, or thickens and lowers into the dense rain-cloud, according to the atmospheric circumstance of the time. In Professor Poey's system, the cirrus and the cumulus are maintained in the dignity of fundamental cloud-types; and the old compound forms of cirro-stratus and cirro-cumulus are retained and turned to excellent account. But the unsatisfactory and philosophically indefinite stratus and nimbus, with the derivative cumulo-stratus, are ruthlessly and, in the writer's opinion, most righteously and deservedly banished. In their place three new and very distinct and characteristic forms are recognized. These new forms, however, it will be at once remarked, are not new in their intrinsic individualities to practical observers. They are, in themselves, old and most familiar acquaintances to all who have closely watched the white ice and mist-forms of the firmament, although they have been without fixed and distinctive designations until Professor Poey has rendered this marked service to meteorology of giving them a "local habitation and a name."

The most important of Professor Poey's new cloud-forms is what he terms the "pallium" or "sheet-cloud." This is the grey or ash-coloured cloud which is spread as a uniform stratum over the whole face of the heavens, and from which rain so commonly falls for hours, and even days at a time. With the settling in of a period of rain, other isolated clouds are continually seen to be gathered in to its under surface, increasing its thickness and mass: it then constitutes what Professor Poey proposes to call the "pallio-cumulus," or true "rain-cloud." As the rain subsides, this dense rain-stratum is seen to break up into formless fragments of cloud without the flat bases, or piled hemispherical summits, of the cumulus, which detach themselves from the mass, and drift

away. These isolated fragments of indefinite and infinitely diversified form, Professor Poey very expressively terms the "fracto-cumulus," or "wind-cloud." The fracto-cumulus, as it is drifted away in the current of the wind, very commonly loosens out into fleecy streamers and dissolves into transparency; but quite as commonly it is gathered and heaped into the true cumulus. The fracto-cumulus is thus either the infantile and immature form of the majestic cumulus, or "mount-cloud," or merely the broken *débris* of the vanishing "sheet-cloud" and "rain-cloud," according to the immediate condition of the atmosphere.

But when, with the departure of rain, the dense stratum of rain-cloud is broken up and dissolved away, a higher and whiter, and altogether distinct stratum of "sheet-cloud" becomes manifest through the chinks. This also is a rain-cloud; but it is a rain-cloud fed of cirrus, rather than of lower mists. This higher form of the pallium is named by Professor Poey, for distinction's sake, the "pallio-cirrus." It is generally formed some hours, or days, in advance of the pallio-cumulus, or denser rain-cloud. With the return of fine weather it is the last to disappear, and disintegrates into cirrus, instead of into fracto-cumulus. There are thus two perfectly distinct families of the "pallium,"—the high ice-pallium and the low mist-pallium. They are, indeed, so distinct that when coexistent, as they always are in the most pronounced rain-seasons, they are divided by an intermediate neutral region of the atmosphere. Professor Poey points out that the pallio-cirrus is then in a state of negative electrical excitement, in common with the air at the surface of the ground, while the pallio-cumulus, and the rain which issues from it, are in a positive electrical excitement; and that electrical discharges continually take place between the two, concomitantly with the pouring down of un-electrified rain from the lower stratum upon the earth. The reciprocal action and reaction of these two oppositely electrified layers of sheet-cloud has, no doubt, to do with the intrinsic economy of the thunderstorm and of the heavier deposits of rain accompanied by electrical manifestations.

Professor Poey's new forms of cloud are thus, succinctly, the "pallio-cirrus," or upper cirrus-sheet cloud, and the "pallio-cumulus," or lower sheet-cloud, and proper "rain-cloud," together constituting the "pallium," or cloud-mantle of compact texture and slow majestic march which in bad weather entirely enshrouds the sky; and the "fracto-cumulus," the irregular dissolving frag-

ments or *débris* of the lower and denser layer of the pallium, which, in suitable circumstances, become the germinal forms of the cumulus.

Some exception has been taken to Professor Poey's revision of cloud-nomenclature upon the ground that what is most desirable is, the contrivance of a system that shall express the cause and method of cloud-formation as well as visible cloud-aspects. The proper answer to this critical exception is, that tried upon this very count, Professor Poey's revision is a move in the right direction. His own argument is, that there is no real structural or formative distinction between cumulo-stratus and cumulus, and that very commonly rain-cloud is not a nimbus of Howard's definition. A moment's consideration suffices to show that the fracto-cumulus of the new nomenclature is a cloud of ever varying *external* form, organically and effectively marked by its unvarying method of organization—the tearing asunder of disintegrating cloud-mass into isolated fragments by the drift of the moving wind. The cirrus is cloud-streak slowly formed in the highest region of the atmosphere by the dull touch of actual frost. Cirro-stratus is the cloud-streak woven into a web, when the frost-touch descends into a lower region of more abundant watery vapour. Cirro-cumulus is the frost-cloud with its angles stippled and rounded away by a mounting up of the air-temperature a little above the condition of freezing. The pallio-cirrus is the high ice-cloud thickened and amplified by abundant moisture, and no less abundant cold, until it approaches, or actually reaches, the points of condensation and deposit. The pallio-cumulus is watery vapour in the lower regions of the atmosphere gathered to the point of more or less copious condensation and deposition. The cumulus is watery vapour condensed in ascending upcasts of the atmosphere by the combined influence of chill and diminution of pressure. In all probability the further steps in the improvement of this especial branch of meteorological science will recognize the soundly philosophic principle that classification should deal quite as largely with inherent cause as with external and incidental form, and should be a matter of explanatory expression quite as much as it is of description and convenience of arrangement and remembrance. In the mean time it seems to the writer that it is precisely because Professor Poey's suggestions run so unmistakably and so admirably in the direction of this desirable consummation, because they deal so largely with deter-

mining intrinsic cause, as well as with external perceptible form, that they are worthy of notice and acceptance at the hands of meteorologists.

It may possibly not be deemed an inapt conclusion of this communication to present, in this place, a concise and compact synopsis of the classification and description of clouds under the revision and amendments of Professor Poey.

*Synopsis of Cloud-classification according to the views of
Professor Poey, of the Havana.*

1. CURL-CLOUD. (*Cirrus*.)

Delicate cloud-filaments of brilliant, or pearly, whiteness, occurring generally at an elevation of above six miles, and lengthened out in the direction of the wind; formed by the aggregation of ice-particles, and indicating the approach of bad weather by their appearance and increase, or of fine weather by their diminution and disappearance; often having a very prolonged existence, when they are the sole form of cloud, and at a great height; increasing upwards on the approach of rain, and downwards on the return of fine weather; rose-tinted by the late and early rays of the setting and rising sun; of considerable diversity of outer aspect; arranged as tufts, feathers, finger-like projections, curled hair, or as parallel or divergent bands.

2. THREAD-CLOUD. (*Cirro-stratus*.)

Smaller, more compact, and more branched cloud-filaments, more or less woven into a continuous stratum; lower, more dense, and with more rapid motion than the pure cirrus. Often almost impenetrable by the sun's rays; assuming the appearance of long and narrow bands when seen on the horizon; rose-tinted by early and late rays of rising and setting sun.

3. CURDLED-CLOUD. (*Cirro-cumulus*.)

Little isolated cloud-balls, resembling flocks of carded cotton, scattered upon the sky; substantially cirro-stratus, with the ice-aiglets rounded into snow, either by its subsidence to a lower region of the atmosphere, or by a slight elevation of atmospheric temperature, the stratification being broken into scattered cloud-

lumps, or balls ; essentially the snow-cloud, as distinguished from the ice-cloud ; region somewhat lower, and motion more rapid, than the region and motion of the cirro-stratus ; red-tinted by rays of rising or setting sun.

4. SHEET-CLOUD. (*Pallio-cirrus*.)

The upper layer of a large, compact, slow-moving, extended mantle of cloud, formed out of cirrus and cirro-stratus by their subsidence into a lower region and by their great increase ; heralding the approach of wet weather, or giving promise of fine weather by its disappearance ; formed earlier and disappearing later than the yet lower layer of the pallium-mantle ; negatively electric, like air in immediate contact with the ground, and separated from the lower layer of the pallium by a clear neutral air-interval.

5. RAIN-CLOUD. (*Pallio-cumulus*.)

The lower layer of extended compact cloud-mantle formed by the condensation and accumulation of unfrozen vapour ; positively electric ; the immediate source of actually falling rain ; reaching to a somewhat higher region of the atmosphere than the cumulus-cloud, but separated from the region of the ice-pallium, or pallio-cirrus, by a clear interval. During thunderstorms electrical discharges take place between the pallio-cumulus and the higher oppositely electrical pallio-cirrus, and the stratum of pallio-cumulus pours forth its superfluity of water devoid of all manifest electrical excitation. As fine weather returns the pallio-cumulus thins away, and breaks up, revealing the layer of pallio-cirrus above ; the disintegration being partly effected by the reabsorption of condensed vapour, and partly by the drifting away in the currents of the wind of fragments of yet condensed vapour in the specific form of fracto-cumulus.

6. WIND-CLOUD. (*Fracto-cumulus*.)

Isolated fragments of dissolving pallio-cumulus, of indefinite, irregular, and infinitely varied form, carried rapidly along in the lower currents of the atmosphere, and very commonly contributing to form the true cumulus cloud.

7. MOUNT-CLOUD. (*Cumulus*.)

Isolated masses of cloud, with a more or less flat and stratified

base, and piled-up hemispherically curved summit, due to ascending columns of air carrying up vapour into higher and cooler regions of the atmosphere favourable to renewed condensation; formed from unfrozen vapour, and belonging to the lower districts of the air. Masses of disintegrated pallio-cumulus are very commonly seen to be built up into cumulus clouds upon the horizon, with or without the intermediate agency of the fracto-cumulus.

XXX. *The Aurora Australis of October 23 and 24, 1870.*

By ROBERT JAMES MANN, M.D., F.R.A.S., &c.

It is worthy of note that a very magnificent display of aurora occurred in the southern hemisphere simultaneously with the grand display witnessed in England towards the end of October. In the Natal papers there occurs the following paragraph:—"On the 23rd and 24th of October the diggers (that is, the men working at the diamond-fields on the Vaal River) witnessed a most extraordinary phenomenon—a brilliant display of aurora australis." And with a view to give adequate point to the fact of exceeding brilliancy, the paragraph adds, with more force than aptness, "the mind of man cannot recall a similar appearance, so far north, of those flashing lights." The writer, no doubt, intended merely to say that he believed no appearance of a southern aurora was remembered or recorded as having been seen so far north. The spot where the observation was made is on the banks of the Vaal River, in about 28° 30' south latitude. It is not, however, quite certain whether this appearance was really an "austral" aurora. Nothing is said of the direction in which the light was seen. The observer, possibly, came at once to the conclusion that the appearance must be an aurora australis, because it was seen in the southern hemisphere, and neglected to note whether the streamers were emanating from the direction of the northern or of the southern magnetic pole. The writer has himself seen Benetnasch, the tail-star of the Great Bear, a degree further south than the station of these miners.

There remains, however, pending the verification of the direction in which the aurora was seen, the interesting fact that a very

splendid display of auroral light was visible in England on the evenings of the 24th and 25th of October, 1870, and that an equally magnificent display of auroral light was observed on the banks of the Vaal River, in South Africa, in latitude $28^{\circ} 30'$ south, on the evenings of the 23rd and 24th of October.

XXXI. Mean Temperature of the Air at Osborne, Isle of Wight, as deduced from Observations taken during the Years 1858–69 (inclusive). By J. R. MANN.

Months.	Dry-bulb, 9 A.M.	Dry-bulb, 3 P.M.	Mean of Dry-bulb, 9 A.M. and 3 P.M.	Mean of Max. and Min. in Air.	True Mean Temperature.
January.....	41°0	39°4	40°2	40°2	40°2
February ...	42°6	40°6	41°6	41°5	41°5
March	43°7	40°6	42°1	41°9	42°0
April	49°4	46°1	47°7	47°8	47°6
May	54°1	51°5	52°8	52°8	52°8
June	59°7	56°7	58°2	58°4	58°3
July	62°6	61°6	62°1	61°4	61°9
August	61°9	59°6	60°7	60°6	60°7
September ...	59°7	56°2	57°9	58°0	58°0
October	53°5	51°5	52°5	52°5	52°5
November ...	44°8	43°2	44°0	44°2	44°1
December ...	42°8	41°1	41°9	42°0	42°0
Mean	51°3	49°0	50°1	50°1	50°1

The corrections which have been applied are those given in Glaisher's Diurnal Range Tables.

XXXII. Eclipse of the Sun, 1870, December 22, as observed at Culloden. By ARTHUR FORBES, F.M.S.

THE eclipse was seen here to great advantage to-day, the sun being, during its duration, almost entirely clear of cloud. At the time of the greatest phase there was a decided diminution of light, to such an extent that marked and prominent objects, as

houses and trees, at three miles distance became dimly visible; and at distances ranging from five to seven miles they could be very indistinctly seen. This was particularly apparent when looking from a height of 60 feet above the ground, all along the horizon between N.N.W. and E.N.E. Some cumulus (clouds before the eclipse, of a yellowish colour) assumed a grey sickly tint, which, indeed, was the colour that pervaded everything at the time of the greatest phase. The diminution of light seemed to be more marked than on the occasion of the eclipse of 1858; but perhaps the difference of the season and height of the sun above the horizon may partly account for this. Some observations on the state of the air were made during the eclipse; but intense frost prevailing, any fluctuation caused by the temporary withdrawal of such a considerable portion of the sun's rays could not be expected to have much effect on the temperature, which, after a minimum on the previous night of $22^{\circ}4$, rose to-day to only 25° . In rising to this maximum it seemed, however, to be retarded after the sun became overshadowed, and even declined one-tenth of a degree at the time of the greatest phase. The barometer slightly fell from 30.109 in. at 11 A.M. to 30.080 in. at 1^h 30^m P.M. The wind blew very gently from S. to S.W., not exceeding five miles per hour, the carry of the clouds (cirro-stratus) being from the S.E. when the eclipse came on, but changing to from N.E. to N.N.E. at the middle of it. It may here be remarked that a change in the "carry" of the clouds has been observed to take place during previous eclipses. In the quantity of cloud (which amounted to only 2) there was a diminution while the eclipse prevailed, leaving the sun so entirely clear that, as has been already said, this very interesting phenomenon was seen to the greatest advantage; and the atmosphere was so transparent that not only could the outline of the moon be clearly traced, but a group of spots on the sun's disk could be distinctly seen though coloured glass without the aid of a telescope. With the exception of these spots, nothing remarkable was detected about the sun itself, although two powerful telescopes were used in viewing it.

XXVIII. *Meteorological Observations recorded in 1869 at the Adelaide Observatory, South Australia, lat. 34° 57' S., long. 138° 38' E., height above sea-level 140 ft. By CHARLES TODD, Observer.*

1869.	Barometer Readings (reduced to 32° Fahr.).				Thermometer (in shade).						Hygro- meter.				Radiation.				Cloud.		Rainfall.	
	Mean at 9 A.M.		Mean at 6 P.M.		Maximum.	Minimum.	Monthly range.	Mean of all Maximum.	Mean of all Minimum.	Mean Daily range.	Mean Tempe- rature.	Temperature of Dew-point.	Wet-bulb force of Vapour.	Humidity (0-100).	Maximum.	Mean.	Minimum.	Mean.	Mean Amount at 9 A.M.	Mean Amount at 6 P.M.	Number of Days it fell.	Amount. in.
	in.	in.	in.	in.																		
January	29.741	29.706	29.681	29.683	104.2	49.5	54.7	84.8	58.6	26.2	71.7	51.3	0.280	49	144.6	126.0	40.0	51.3	5.0	3.6	6	0.29
February	29.686	29.636	29.601	29.618	106.2	49.8	57.4	84.1	61.1	28.0	72.6	51.1	.376	47	141.6	124.9	36.0	54.4	5.1	3.2	6	0.43
March	29.683	29.638	29.608	29.639	101.5	49.5	55.0	81.9	59.9	28.0	70.3	51.6	.388	51	141.0	120.6	37.1	52.4	5.3	4.7	8	1.91
April	30.055	29.994	29.966	29.970	84.7	46.7	38.0	72.7	53.9	19.8	68.3	48.8	.245	60	126.4	111.4	36.0	46.3	4.8	4.7	11	0.99
May	29.866	29.816	29.802	29.816	76.0	41.5	34.5	64.0	48.4	13.6	56.3	46.1	.314	69	120.8	100.8	32.3	40.7	5.1	5.3	16	1.67
June	30.086	30.048	30.048	30.058	70.5	37.5	33.0	61.0	47.7	13.8	54.4	46.5	.316	74	114.9	91.0	35.0	41.5	5.3	4.9	17	2.26
July	30.183	30.147	30.147	30.156	66.0	35.2	30.8	60.5	44.0	16.6	52.3	45.2	.269	69	115.0	109.0	37.0	38.4	4.7	4.1	11	0.75
August	30.087	30.088	30.088	30.093	74.2	36.2	36.0	68.7	46.5	17.2	55.1	45.9	.277	64	127.2	117.4	36.4	40.6	6.6	4.9	11	1.63
September ..	30.087	30.088	30.088	30.094	84.2	35.9	45.3	69.7	46.9	22.8	58.3	41.8	.266	54	138.4	124.0	36.5	40.4	4.7	3.6	9	1.04
October	29.936	29.757	29.757	29.763	87.7	41.5	46.2	72.7	50.4	22.3	61.6	44.3	.291	54	145.0	127.3	33.3	44.4	6.6	4.2	12	1.63
November ...	29.775	29.731	29.731	29.733	106.0	45.8	60.2	81.1	56.6	24.5	68.8	47.1	.383	46	160.6	135.2	37.3	52.2	5.2	5.6	6	1.69
December ...	29.741	29.696	29.696	29.701	112.0	49.5	63.5	88.5	53.3	26.5	71.0	48.6	.443	45	156.0	136.1	43.0	54.1	4.3	3.1	3	0.16
Year	29.947	29.992	29.992	29.996	112.0	35.2	76.3	79.3	59.6	20.7	63.0	46.3	.431	55	160.5	118.7	36.5	46.4	5.2	4.3	123	14.73

* On wool.

XXXIII. *Meteorological Observations recorded in 1869 at the Adelaide Observatory, South Australia, lat. 34° 57' S., long. 138° 38' E., height above sea-level 140 ft. By CHARLES TODD, Observer.*

1869.	Barometer Readings (reduced to 32° Fahr.).				Thermometer (in shade).						Hygro- meter.				Radiation.				Cloud.		Rainfall.	
	Mean at 9 A.M.		Range.		Maximum.	Minimum.	Monthly Range.	Mean of all Maximum.	Mean of all Minimum.	Mean Daily Range.	Mean Tempera- ture.	Wet-bulb Force of Dew-point.	Humidity (0-100).	Solar.		Terrestrial.*		Mean Amount at 9 A.M.	Mean Amount at 5 P.M.	Number of Days it fell.	Amount.	
	in.	in.	in.	in.										Maximum.	Minimum.	Maximum.	Minimum.					Mean.
January	29.741	29.706	29.631	29.633	0.679	104.2	46.5	53.7	53.6	26.2	71.7	51.3	0.380	49	144.6	126.0	40.0	51.3	5.0	3.6	6	0.29
February	29.86	29.826	29.691	29.618	0.573	106.2	48.8	57.4	54.1	23.0	72.6	51.1	37.6	47	141.6	124.9	39.0	54.4	5.1	3.2	6	0.43
March	29.933	29.908	29.8	29.539	0.766	101.5	46.5	55.0	51.9	26.0	70.3	51.5	38.3	51	141.0	120.6	37.1	52.4	5.3	4.7	8	1.91
April	30.055	29.984	29.866	29.701	0.685	84.7	46.7	38.0	72.7	18.3	63.3	48.8	34.3	60	126.4	111.4	38.0	46.3	4.6	4.7	11	0.99
May	29.966	29.916	29.822	29.475	0.727	76.0	41.5	34.5	64.0	15.6	56.2	46.1	31.4	69	120.3	100.8	22.2	40.7	5.1	5.3	16	1.87
June	30.068	30.048	29.936	29.836	0.794	70.5	37.5	33.0	61.0	47.7	12.3	54.4	43.5	74	114.9	91.0	28.0	41.5	5.3	4.9	17	2.26
July	30.138	30.130	29.977	29.866	0.801	68.0	35.2	32.9	60.5	44.0	16.5	52.2	42.2	69	116.0	100.0	27.0	38.4	4.7	4.1	11	0.75
August	30.070	30.037	29.931	29.853	0.743	74.2	36.2	36.0	63.7	46.5	17.2	55.1	45.9	77	127.2	117.4	29.4	40.5	6.5	4.9	11	1.83
September	30.037	30.033	29.933	29.824	0.759	84.2	35.9	43.3	69.7	46.9	22.8	53.3	41.3	54	136.4	124.0	26.5	40.4	4.7	5.6	9	1.04
October	29.826	29.787	29.809	29.323	0.867	87.7	41.5	46.2	72.7	50.4	22.3	61.5	44.3	54	149.0	127.3	26.3	44.4	6.8	4.2	12	1.33
November	29.775	29.721	29.617	29.223	0.794	106.0	45.8	60.2	61.1	24.5	68.8	47.1	33.3	45	160.5	125.3	27.3	52.2	5.2	5.6	6	1.99
December	29.741	29.686	29.611	29.186	0.816	112.0	48.5	63.5	59.8	26.5	71.0	49.6	34.3	45	159.0	126.1	29.0	54.1	4.3	3.1	3	0.16
Year	29.947	29.992	29.497	29.186	1.303	112.0	36.2	76.3	73.3	30.7	63.0	46.3	33.1	56	160.5	118.7	26.5	46.4	5.2	4.3	123	14.72

* On wood.

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1871, MARCH 15.

CONTENTS.

Communications made at the Ordinary Meeting:—

	Page
XXXIV. On Evaporation, Rainfall, and Elastic Force of Vapour.— J. R. Mann	285
XXXV. Abstract derived from Meteorological Observations made at the British Cemetery, Scutari, Constantinople, in the Years 1865, 1866, 1867, 1868, and 1869. Lat. 41° N., Long. $29^{\circ} 3'$ E. Height above sea 60 feet	298
XXXVI. On the Temperature of the Dew-Point.—George Dines, F.M.S.	299
XXXVII. On a New Electro-Magnetic Anemometer.—John J. Hall, F.M.S.	301
XXXVIII. Results of Meteorological Observations taken at the Observa- tory, Adelaide, South Australia, lat. $34^{\circ} 57'$ S., long. $138^{\circ} 38'$ E., height above the sea-level 140 feet.—Charles Todd, F.R.A.S., Superintendent of Telegraphs, and Government Observer.....	304

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1871, April.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.] 1871, MARCH 15. [No. 54.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Embrey, George, *George Street, Lozells, Birmingham*;
Scott, Robert H., M.A., F.R.S., &c., Director of the Meteorologi-
cal Office, 116 *Victoria Street, S.W.*;
Turner, John, *Loughboro' Place, Owen Street, Birmingham*;
were balloted for and duly elected Fellows of the Society.

The names of Two Candidates for admission into the Society
were read.

XXXIV. *On Evaporation, Rainfall, and Elastic Force of Vapour.*
By J. R. MANN.

HAPPENING to read some notes on evaporation appended to the elaborate account of the yearly rainfall for 1869, compiled by Mr. G. J. Symons, F.M.S., I was led to look over my observations of the past thirteen years, and to make a number of experiments, with the view to discover what rule or formula governed

the amount of evaporation from water when exposed in the open air.

In my first experiments out of doors, I found that the amount of error in measuring the small variations of short periods prevented me obtaining any accurate idea of the fluctuations, in the amount of evaporation, that followed the constant and incessant alteration in the state of the atmosphere and the temperature of the water.

I therefore looked to artificial means for obtaining a greater amount of evaporation under more fixed conditions; and having obtained some certain basis, I endeavoured therefrom to devise a rule by which the amount of evaporation going on under natural conditions might be arrived at.

After very many failures, I adopted an arrangement which, I think, gave satisfactory results. An ordinary evaporating-vessel, about 8 inches in diameter and $1\frac{1}{4}$ inch deep, containing a measured quantity of water was floated in a larger vessel of water; the large vessel was placed upon an ordinary gas-stove, which gave the means of regulating the heat in the water contained in the evaporating-vessel to a considerable nicety, and of retaining it for a length of time at one degree of temperature.

As a sample of these experiments, I found that the evaporation in air at

Fahr.	in.		Dry bulb.		Wet bulb.
192°	was about 0·777	in depth per hour	64·0	...	63·0
193	" 0·789	" "	64·0	...	63·0
179	" 0·568	" "	61·5	...	55·0
151	" 0·253	" "	61·5	...	55·0

After many endeavours to arrive at some formula for calculating the amount of evaporation, the following one, devised from that for the flow of gases, was, I found, as accurate through all the variations of temperatures, &c. as I could anticipate my experiments to be:—

$$\left. \begin{array}{l} \text{Depth of evaporation per} \\ \text{hour in inches} \end{array} \right\} = 1\cdot5 \sqrt{T + \left\{ 1 - \left(\frac{e}{e_s} \right) \right\}} \times D,$$

where T = the absolute temperature of the water (at surface) evaporating in degs. Fahr. (that is, $461 +$ the ordinary scale),

e = elastic force of the vapour in the air in inches,

e_1 = elastic force of vapour due to the temperature of the water evaporating Fahr.'s scale,

D = the density or weight of the issuing vapour due to the temperature of the water in pounds avoirdupois per cubic foot.

As an example from one of the above experiments:—

	Elastic force.
Dry. Wet.	
Log (64° : 63°) =	0.560 = 1.7481
Log .. 193° .. =	20.320 = 1.8079
	2.4402
	$\frac{1}{4}$
Log $\left(\frac{e}{e_1}\right)^{\frac{1}{4}}$ =	1.6100
No.	0.408
	1.000
Difference =	0.592
Log difference =	1.7723
Log (461 + 193) =	2.8155
	2) 2.5878
	1.2939
Log D =	2.4201
Log 1.5 =	0.1760
	1.8900
	0.777

Altering the formula so as to use Glaisher's Hygrometrical Tables only, we have

$$\left. \begin{array}{l} \text{Depth evaporated per} \\ \text{hour in inches} \end{array} \right\} = \frac{\sqrt{T \times \left(1 - \left(\frac{e}{e_1}\right)^{\frac{1}{4}}\right) \times G}}{4666};$$

where G = weight in grains of a cubic foot of vapour due to the temperature of the water, as given in Table VI. Glaisher's Hygrometrical Tables, and T, e, e_1 , the same as in the preceding formula.

As an example, temperature of the air, dry bulb $74^{\circ}2$, and wet bulb 70° , temperature of water 72° .

$$\begin{array}{r}
 \text{Log } 0.660 = \bar{1}.8195 \\
 \text{Log } 0.785 = \bar{1}.8948 \\
 \hline
 \bar{1}.9247 \\
 \frac{1}{4} \\
 \hline
 \text{Log } \left(\frac{e}{e_1}\right)^{\frac{1}{4}} = \bar{1}.9811 \\
 \hline
 \text{No. } \dots = 0.957 \\
 \hline
 1.000 \\
 \hline
 \text{Difference } 0.043 \\
 \hline
 \text{Log difference} = \bar{2}.6384 \\
 \text{Log } (461 + 72) = 2.7267 \\
 \hline
 2) 1.3601 \\
 \hline
 0.6800 \\
 \text{Log } 854 = 0.9314 \\
 \hline
 \text{Sum} = 1.6114 \\
 \text{Log } 4666 = 3.6691 \\
 \hline
 \bar{3}.9423 \\
 \hline
 \text{No.} = 0.0087 \text{ in.} \\
 \hline
 \text{And it was } 0.0083 \text{ in.}
 \end{array}$$

This formula is, I believe, quite accurate except under very exceptional atmospheric conditions. The exceptions would be from extraordinary calms and from very tempestuous weather, the first lessening the amount of evaporation as compared with calculation, the latter increasing it. There must be a perceptible current passing over the water, say of 3 or 4 feet per second, and it is seldom but what there is this amount of motion in the air; or otherwise, if there is absolutely no movement of the air over the surface of the water, the evaporation is clogged; as if, for instance, an evaporating-vessel is placed in a small close room the evaporation is often not one-tenth of that given from the foregoing formula.

Strong currents of air over the surface of the water increase the amount of evaporation, a very strong draught of, say 30 feet per second, doubling or tripling that calculated from the foregoing formula, even when the elastic force of the air is obtained from the hygrometer placed in the current. This difference from the formula may be partly due to the ripple or agitation of the surface; but I imagine it is also due to the elastic force, as acting on evaporation, not being correctly taken by the hygrometer; the wet bulb not being sensitive enough, the current only acting with force on one side of it. The dry- and wet-bulb hygrometer, if exposed to a strong current of air, shows a less amount of elastic force of vapour, than it does when kept out of the direct draught of the same air.

The amount of evaporation from a vessel floated in an open exposed pond agreed with the calculated amount given by the foregoing formula.

My experiments showed that the amount of evaporation depends almost wholly upon the area of the surface of the water, fully exposed as in the sea or unsheltered pond, upon the temperature of the water at the surface, and upon the elastic force of the air passing over the water.

The height of the barometer has doubtless a slight influence upon the amount of evaporation as from a table of boiling-temperatures of water, we have:—

Barometer. in.	Temperature of boiling-point.
31·0	213·57
30·0	212·00
29·0	210·38
28·0	208·69

And if the evaporation varies accordingly, the following coefficients are probably correct:

Height of Barometer. in.	Coefficient. in.
31·0	0·993
30·0	1·000
29·0	1·008
28·0 ..	1·016

Showing that with a high barometer we have about 1 per cent. less, and with a low barometer about 1 per cent. more of evaporation than the formula gives.

Although I found the preceding formulæ give satisfactory results when applied to a great number of experiments under artificial and ordinary natural circumstances, yet it is rather tedious to work out, and the following short formula, adopted from one given in Ure's Dictionary, is, I found, nearly correct for *great* differences of elastic force:

$$\text{Depth evaporated } \left\{ \begin{array}{l} \text{per hour in inches} \end{array} \right\} = 0.04 \left(\begin{array}{l} \text{Elastic force of} \\ \text{water-temp.} \end{array} \right\} - \left\{ \begin{array}{l} \text{Elastic force of} \\ \text{the vapour in air} \end{array} \right\}$$

As an example, taking the foregoing experiment at 179°, (14.83—371) .04 = .578, and my experiment gave .568.

But this rule is not correct for small differences of elastic force, as it then gives much too little. It should not be used when the difference is less than 0.4 inch.

In experiments the height of the surrounding rim of the evaporating-vessel above the surface of the water, as compared with its diameter, had, I found, as pointed out by Mr. Dines, a very material effect upon the amount of evaporation. When the elastic forces approximate in amount, the reduction below that given by the foregoing formulæ is very considerable; but when there is a great difference between the elastic forces, the reduction is not so great.

As, for example, in experiments where the difference of the elastic forces of the vapour of the water and of the air was but 0.74 in., —0.56 = .18 in., the evaporation, when the water-surface was level with the edge of vessel, agreed with calculation.

When the water-surface was 1.25 diameter of the vessel below the rim, the evaporation was only 0.75 of the calculated amount.

When 4½ diameters below the rim it was but ½ of the calculated amount.

When 6 diameters below, it was but ⅓ of the calculated amount.

And in a very narrow tube 0.5 in. diameter, when the water was 12 diameters below the rim, it was next to nothing over many days, not ⅓ of an inch in a week; while, in one experiment, where the difference of the elastic forces was 19.5 inches, and the surface of the water 4.5 diameters below the rim, the evaporation was 0.62 of the calculated amount, and in another similar experiment it was 0.64.

This retardation is due to the clogging of the vapour over the water-surface. It requires a current of air to take it away as it is formed.

From a few trials made with sea-water, I believe the evaporation from it is a little less than from fresh water; say, about 5 per cent. less than that given by the foregoing formulæ.

Although I have stated that the depth of the water which is evaporating does not affect the amount of evaporation from the surface, only through its influence on the surface-temperature; yet it may be doubtful whether, in water where the surface-temperature is much in excess of that below, there is not a small amount of downward action as well as an upward one. But my experiments were not delicate enough to enable me to notice this.

To test the foregoing formulæ under unusual circumstances, I made some experiments with very cold water and some with the evaporating-vessel kept cold in ice. With the water kept between 56° and $57^{\circ}=0.457$ elastic force, while the air was $73^{\circ}.6$ dry, and $64^{\circ}.4$ wet-bulb, 0.479 elastic force; instead of any evaporation there was, as I anticipated, an augmentation. In three hours the water increased $.002$ of an inch in depth.

With the evaporating-vessel kept cold in ice (at about 43°), while the air (on a very warm day) was 88° dry, and $66^{\circ}.4$ wet bulb, there was again an augmentation.

I tried to arrive at some rule for calculating this augmentation, condensation, or dew, but could not succeed; but using the foregoing formulæ, transposing the elastic forces of the water and air-vapour, I found it about $\frac{1}{3}$ of that from water to air.

The material of the evaporating-vessel used in experiments in the open air has a great influence upon the amount of evaporation from it, as well as the vessel's position, from it being more or less exposed to the sun, as also the depth of water in the vessel; but all these influences only act on the evaporation by influencing the temperature of the surface of the water in the vessel.

The method I adopted generally for measuring the amount of evaporation was by using an evaporating-pan 8 inches in diameter, and measuring the water in a measuring-glass 2 inches in diameter, invariably rinsing the measuring-glass out before using it, and taking the reading of the lowest or underside of the depression in the water-surface by the scale on the side of the glass, the measuring-glass being always placed exactly in the

same position on a marked pedestal at the time of reading. And from the results of trials by pouring the water backwards and forwards, I think readings to the thousandth of an inch can be so taken with tolerable correctness. Of course allowance has to be made, when there is a difference of temperatures in the water at the beginning and end of an experiment, for the increase or decrease in its volume or depth.

I would beg to offer a few observations I made relative to ordinary evaporation in nature. As before stated, the elastic force of the vapour in the air is one element, and the elastic force due to the temperature of the water-surface is the other important element. Now, in noting the temperature of the water in several still ponds, the temperature of the surface-water increases during a sunny warm day very considerably, and from radiation of heat during the night again declines. But the temperature at a depth of 8 feet shows scarcely any diurnal variation.

Thus, for example, on the 28th of September a pond, at 6 A.M. and 2 P.M., gave the following temperatures:—

	6 A.M.		2 P.M.
Temperature at surface of water	58·0	...	75·5
" 6 inches below surface ...	58·0	...	68·0
" 1 foot " " " ...	58·0	...	62·0
" 3 feet " " " ...	57·7	...	58·5
" 8 " the bottom	57·7	...	58·0
While temperature of air in tree-shade was	53·0	...	67·0

A shallow pond on the extremely warm day, 22nd of July, 1870, at 4 P.M., gave a temperature at the surface of 85°, and at the bottom, 3 feet 6 inches deep, the temperature was 76°.

Aquatic weeds or plants in a pond, when they rise to just below the surface, considerably increase the surface-temperature by keeping the heat at the surface. In a large pond on the 22nd of July at 3 P.M., the temperature of the surface-water on weeds close to the surface was as high as 89°; the water was 6 feet deep.

The water in the above-mentioned ponds was perfectly still; the temperature of the surface-water in a moving river or the tide-moved water of the ocean, from the intermingling of the surface-water with that beneath, does not of course show such diurnal variations.

A pond fully exposed to the sun's rays and unsheltered would

give nearly a maximum of evaporation; whilst a pond overshadowed and surrounded with dense foliage would give nearly a minimum of evaporation, and might, even on the warmest day and when the air was far short of its maximum humidity, suffer no loss whatever.

Bullrushes and such-like plants growing in shallow ponds or marshes, from sheltering and screening the water-surface and protecting it from draughts of air, protect it from evaporating. Trees and copse have, of course, the same effect on the earth; the dense tangled forest itself absorbs the sun's heat, sheltering and retaining the water and moisture of the earth for its own sustenance.

The preceding observations I have endeavoured to extend theoretically to the evaporation that supplies our rain-clouds. And here I would premise a few remarks; the ocean is, of course, the grand fountain from which the rain-cloud is supplied, the supply from evaporation from rivers and land being, at least in this island, insignificant in comparison therewith*. Our south-west winds, coming across the surface of the ocean, become saturated and laden with vapour, and passing over the land north-eastwards to a colder climate, gradually part with it, the air becoming colder, not being able to retain so great an amount of vapour. Also coming in contact with mountain-ranges which it has to ascend, expanding in so doing, to pass over them, it, as in the Cumberland district, rapidly parts with its vapour, which falls on the lee side of the elevation. Cold currents of polar air traversing over this lower or equatorial current, cool it and cause it to shed its vapour. A polar current crossing over this,

* Experiments, in some cases extending over an area of many square miles, made by engineers in this country and in America, for the purpose of ascertaining the percentage of the rainfall that could be collected from various watersheds, shows that the amount that can be collected, or that flows off from natural surfaces, is very variable; but in many cases it was proved to be from one-half to two-thirds of the total rainfall. Very possibly the amount evaporated of the rainfall over all England is from 30 to 50 per cent. of the yearly total; yet, probably, not 5 per cent. of the yearly evaporation in England descends again as rain on English soil; the greater portion doubtless falls on the Continent of Europe north-eastwards from England, the remainder being diffused probably over the whole globe.

our south-west wind, at nearly right angles, causes, I believe, our great rainfalls in South and Midland England.

Continued north-easterly winds, such as have prevailed here to such an extent this year (1870), give us dry weather, from their capacity, as they become warmer, to hold or absorb a greater amount of moisture; and as they travel to warmer climates they absorb the local evaporation, and, if long-continued, they parch up the ground. The more the south-west or equatorial wind favours us by making this its road northwards the more rain we have; if, instead, it favours other places, and leaves the lower three miles of the air-stratum of our territory for the passage southward of the polar current, then here we have a dry season.

The yearly amount of heat the earth receives from the sun, we may believe is a constant quantity; the yearly radiation of heat from the earth must be so, or nearly so; and the yearly amount of heat absorbed in evaporation from the whole earth, which evaporation, in regard to heat, results in carrying this heat from one part to another of the earth, may also be nearly a constant quantity. And very possibly the variation in the yearly rainfall in Britain and places similarly situate as to latitude, depends entirely upon their position in respect to the paths of the yearly interchange of the equatorial and polar currents.

Believing that the amount of evaporation from the eastern side of the North Atlantic supplies the rain of Europe, and is what principally concerns us as to evaporation, I have endeavoured to arrive at some idea of the possible amount of evaporation therefrom. But my data are very problematical, and my result is consequently so too. We require the mean temperatures of the surface of the sea and the mean elastic forces of the air in contact with it. At Osborne, I this year find the sea-temperature in June 68°, July 68°, August 67°, September 68°, October 54°; the others employed below are assumed.

The following Table is based upon assumed but probable temperatures of the surface of the sea; the elastic force of vapour in the air is from a twelve years' mean at Osborne; and the last column gives the probable corresponding amount of evaporation from the sea by the foregoing formulæ.

	Sea Temp.		Corresponding elastic force.		Osborne, elastic force of vapour.		Evaporation from the sea. in.
January	44	.....	·288	.....	·228	.....	2·84
February ...	46	.....	·311	.....	·240	.....	2·90
March	49	.....	·348	.....	·237	.....	4·33
April	53	.....	·403	.....	·296	.....	4·33
May	57	.....	·465	.....	·355	.....	4·81
June	63	.....	·576	.....	·411	.....	6·80
July	68	.....	·684	.....	·464	.....	8·67
August	67	.....	·661	.....	·463	.....	7·85
September ...	63	.....	·576	.....	·442	.....	5·70
October	54	.....	·418	.....	·353	.....	3·45
November ...	49	.....	·348	.....	·255	.....	3·78
December ...	46	.....	·311	.....	·244	.....	3·10
Total							58·56

Dead calms would lessen the amount of evaporation as calculated, and stormy weather would increase it.

If we calculate the vapour in the atmosphere at Osborne, approximately, by multiplying the mean elastic forces by 7·8, we obtain the numbers in the first column in the following Table; and if we divide these numbers by the daily amount of evaporation for each month, to be obtained from the preceding Table, we obtain the last column; or the mean number of days for each month, required of such rate of evaporation, to saturate dry air to the amount of the monthly means at Osborne.

	Water in Atmosphere. in.	Number of Days' Evaporation required to obtain this.
January	1·7	18
February	1·9	18
March	1·8	13
April	2·3	16
May	2·8	18
June	3·2	14
July	3·6	13
August	3·6	14
September	3·5	18
October	2·8	25
November	2·0	16
December	1·9	19

Now, if we assume that a space of the North Atlantic equal to

the area of Europe and west-south-west of it, furnishes a mean amount of evaporation equal, as in the Table, to 58 inches in the year, and that one-half of this falls as rain back into itself, we have yet 29 inches left to be carried over Europe by the south-west or equatorial current, *plus* re-evaporation from rivers and land; and to distribute this is required, if the air loses 1 inch depth of vapour per year, a forward or equatorial current in the atmosphere of some 58,000 miles per annum,

$$\frac{2000 \times 29}{1} = 58,000.$$

From the rainfall and moisture in the air at various places, I imagine some tolerably correct idea of the movements of the air could be traced.

For instance—

	Year 1868.	Osborne.	Greenwich.	
Mean weight of 1 cubic foot of air	588	grs.	539	grs.
„ vapour in air	3.8	„	3.4	„
Corresponding amount of water in at- mosphere	} 2.508 in.	}	2.244 in.	}
Rainfall				
Mean temperature	52°.1	„	51°.5	„
Vapour to saturate these temperatures	4.4		4.3	

Now if we suppose that the rainfall averaged 29 inches between Osborne and Greenwich, and that this rain was furnished by the air which passed Osborne, the air consequently, when it reached Greenwich, had less vapour in it. Now the difference, or loss, was, as above stated, .264 inch; therefore eighty miles distance between Osborne and Greenwich multiplied by 29 inches rainfall, and divided by .264 = 10,000 miles travelled by the air per year from Osborne to Greenwich, supposing every mile of the flowing air sustained that full loss and alone contributed to the difference—20,000 miles if half the loss, and 50,000 miles if one-fifth the loss. The total movement at Greenwich was 106,000 miles.

The air, in travelling across Europe north-eastwards, most probably loses one-half its vapour $3.8 \div 2 = 1.9$ grains, and 0.4 was lost between Osborne and Greenwich; therefore the air would travel five times the distances as to Greenwich with corresponding losses of vapour. If 50,000 miles per annum is the amount of movement north-eastwards, then the air passing Osborne from the ocean would supply $80 \times 5 \times 5 = 2000$ miles onwards in Europe,

with 29 inches of yearly rainfall. A less *depth* of air-movement would lessen this rainfall or distance; and re-evaporation from the land extend them.

I have treated the amount of moisture in the air as that fraction of the total weight of the atmosphere that the vapour in a cubic foot near the earth is of the total weight of that cubic foot. But if we allow for the decrease of temperature in the upper air and hold that that upper air has only the same degree of humidity (corresponding to its lower temperature) as the lower air, then the amount would be only about one-fourth of that I have assumed. But as the vapour floats when partly condensed (as in clouds), the assumed amount is most probably the correct one, the lower depth (perhaps about three miles) of the atmosphere containing this extra vapour.

The quantity of vapour in the air might be arrived at with tolerable accuracy by such a calculation as the following, which, if the quantities of vapour and elastic forces I assume were nearly correct, would tend to prove that the moisture in the air is that portion of the total weight of the atmosphere that the vapour in a cubic foot near the earth is of the total weight of that cubic foot. In Symons's *British Rainfall for 1869*, p. 90, there is given a diagram and full account of a heavy fall of rain on the 27th of November, 1869, over the southern half of England. If in this rain we suppose the south-west current to supply the vapour, and that a polar current passing over and across it condensed its vapour, we have a length along the south-west current of about 400 miles over which 0·75 of an inch of rain fell. Now, if the number of grains of vapour in this current on its entry into Cornwall was about 4 grains, this multiplied by ·66 = 2·64 inches depth of water in this air; and if the velocity of the current was twenty miles per hour for twenty hours, we have 400 miles forward movement. And if the vapour at the end of the twenty hours was reduced to 2·8 grains, this multiplied by ·66 = 1·85 in. depth of water; we have therefore $2·64 - 1·85 = ·79$ inch of vapour lost, an amount equal to the actual rainfall.

December 6.—Since writing the above, I have been favoured with copies of observations taken in Cornwall, Norfolk, and Suffolk, and I find the differences in the elastic forces at those places are almost exactly what I had estimated them at in the above calculation.

XXXV. *Abstract derived from Meteorological Observations made at the British Cemetery, Scutari, Constantinople, in the Years 1865, 1866, 1867, 1868, and 1869. Lat. 41° N., long. 29° 8' E. Height above sea 60 feet.*

Months.	Barometer corrected for Temperature.		Self-Registering Thermometers on a "Glaisher Stand."				Mean Humidity for each Month (saturation = 100).	Rain.		Clouded Sky: per cent. covered.
	Mean Height.	Mean Range.	Mean Temperature.	Mean Daily Range.	Mean of Greatest Range on any one Day of each Month.	Mean of Least Range on any one Day of each Month.		Mean amount collected 8 inches above ground.	*Mean Number of Days.	
January	in. 29.968	in. 0.769	° 42.2	° 12.7	° 22.5	° 4.8	82.5	in. 3.07	95	68
February	29.994	0.754	42.2	14.4	23.7	7.0	79.6	2.46	15	63
March	29.767	0.711	48.4	16.2	26.1	7.4	77.8	4.11	18	70
April	29.944	0.705	51.5	19.3	27.9	10.2	72.2	1.24	10	49
May	29.928	0.435	61.0	21.9	30.7	12.6	67.9	1.03	7	40
June	29.856	0.404	69.1	22.7	31.3	15.1	64.0	1.93	6	37
July	29.805	0.401	74.2	23.7	30.9	13.4	61.8	1.30	4	29
August	29.811	0.425	74.2	23.5	31.2	16.6	63.6	2.56	5	29
September	29.957	0.443	67.6	22.0	29.0	12.0	68.2	2.54	7	49
October	29.983	0.473	62.1	18.7	28.3	9.0	74.2	3.98	10	56
November	29.984	0.748	49.9	14.1	26.2	6.9	76.3	5.04	16	69
December	30.053	0.866	44.6	13.0	23.1	5.5	76.5	2.81	15	63
Mean annual values	29.923	0.594	57.3	18.5	27.6	10.0	72.1	32.1	128	52

BAROMETER.		TEMPERATURE.	
Highest.....	in. = 30.593 Feb. 14, 1867	Highest.....	° 103.6 June 22, 1869
Lowest	= 29.259 Mar. 24, 1868	Lowest	= 13.0 Jan. 25, 1869
Greatest range in any one month	= 1.100 Dec. 1867	Greatest range in any one month	= 50.6 May 1869.
Least range in any one month	= 0.280 May 1868.	Least range in any one month	= 29.2 Dec. 1868.

N.B. The means of barometer, temperature of evaporation, humidity, and cloud are calculated from observations at 9 A.M. and 3 P.M.

TEMPERATURE.

Highest	° 103.6 June 22, 1869
Lowest	= 13.0 Jan. 25, 1869
Greatest range in any one month	= 50.6 May 1869.
Least range in any one month	= 29.2 Dec. 1868.

RAINFALL.

Greatest fall in one day	in. = 4.06 Sept. 25, 1866
Greatest fall in one month.....	= 8.67 Oct. 1866
Greatest fall in one year	= 40.37 in 1866
Least fall in one year	= 21.31 in 1869

XXXVI. *On the Temperature of the Dew-Point.*

By GEORGE DINES, F.M.S.

WHILE making some experiments connected with evaporation (see Proceedings of Meteorological Society for November 15, 1870), it was found that when the difference of the dry- and wet-bulb thermometers amounted to 8° or 9° , evaporation commenced from the surface of water at a time when the thermometer immersed in the water showed a temperature of from 3° to 4° below the temperature of the dew-point as obtained by calculation; but on repeating the experiments in air saturated with moisture, when the dew-point temperature could be obtained direct from the thermometer, the dew-point temperature, and that of the water when evaporation commenced, agreed with each other. As no satisfactory reasons have been assigned for this discrepancy, I made other experiments, as follows:—small globes and cylinders, both of glass and metal, were used, the substance of which was made as thin as possible; these were filled with iced water; a thermometer, with the bulb $1\frac{1}{2}$ inch in length, was inserted in the water, the stem of the thermometer passing through the centre of the stopper; the whole was then suspended from the beam of a delicate balance. The outsides of the vessels were, of course, immediately covered with condensation, the amount of which was only occasionally noted, the one object of the experiments being to determine the exact temperatures of the water at the time when condensation ceased upon the surface of the vessels, and the moisture deposited upon them commenced to evaporate; that time was clearly shown by the stationary position of the index-rod attached to the balance, just previously to its commencing a retrograde movement. If the thermometer immersed in the water at the time this change took place fairly represented the temperature of the outside of the vessel, it would, without doubt, give also at the same time the true dew-point temperature. Every care was taken with the covering and supply of moisture to the wet-bulb thermometers; and as an additional precaution two sets of dry and wet-bulbs were used, the differences (8° to 9°) of which did not vary much from each other; but those which gave the widest readings, and consequently the lowest dew-point, were taken. Whether the vessels used were larger or smaller, of glass or of metal, or whether the moisture upon the outside was allowed to accumulate almost in drops,

or the film of moisture so thin as to be scarcely weighable, the results were nearly the same; condensation ceased and evaporation commenced from the surface of the vessels at a time when the water inside the vessels was 3° to 4° below the temperature of the dew-point as obtained by calculation.

It will be objected to these experiments that the thermometer placed in the water does not give the true temperature of the outer surface of the vessel from which the evaporation takes place; I fully admit the force of this objection; but does it not apply with equal force to both Daniell's and Regnault's hygrometers as at present used?

There are, however, these differences in the method of operation; in one case the ether in which the thermometer is immersed is gradually cooling, whereas in my experiments the water is gradually getting warmer; again, in one case the eye is used to determine the time at which condensation begins; in my experiments a delicate balance is substituted for the eye; but I can see no reason in these differences why the results should vary so greatly. I have not compared the results obtained by the wet- and dry-bulb hygrometer with those of Daniell's and Regnault's; this has been done by others, and found to agree very nearly; and I have therefore no reasons to conclude that the factors given in Table I. of Glaisher's Hygrometrical Tables are incorrect, as far as their agreement with Daniell's and Regnault's hygrometers are concerned.

The experiments noticed in this paper have been made at night by artificial light, and therefore under some disadvantages; as the summer advances, I hope to repeat some of them by daylight, but, judging by former experience, do not expect it will alter the results. I cannot at present see my way out of the difficulty; and as the importance of a correct determination of the dew-point temperature cannot be overrated, I have taken an early opportunity of calling the attention of the Society to these experiments, with the hope that some one with more favourable opportunities than myself may be induced to take up the question.

XXXVII. *On a New Electro-Magnetic Anemometer.*

By JOHN J. HALL, F.M.S.

HAVING some time since experienced considerable difficulty in using the ordinary form of Robinson's anemometer owing to the want of sufficient exposure, I directed my attention to, and succeeded in devising an electrical arrangement to overcome this difficulty, and at the same time introduced an efficient horary means for the determination of interval or horary velocities.

The following is a brief *résumé* of its principles and construction :—the anemometer consists essentially of two parts, which are respectively termed the velocity-apparatus and registering-apparatus. The first is an ordinary set of Robinson's hemispherical cups, which move in a horizontal plane and communicate their motion downwards by a vertical arbor into a brass box, where it is reduced in angular velocity (according to the length of the arms supporting the cups), and causes an ebonite contact-disk, or commutator, in which two platinum contact-pins are fixed, equidistant from one another projecting on either side of it, to revolve in 0·1 mile. An insulated metallic lever, having a platinum working-face, which best resists corrosion caused by the atmosphere or dust, stands on either side of the disk ; so that upon the completion of every 0·05 mile one or other of the contact-pins comes in contact with the two levers which form the terminals, and completes the circuit. The levers are then raised a few degrees and, after the transit of the pin, fall back to their normal position, ready to be taken up by the next pin, and so on.

The vertical arbor, the pivot of which is the principal part of the apparatus requiring lubrication (more especially from the fact that this part of the anemometer may be fixed in a position not always accessible to the observer), stands in a *truncated* conical cup, the interior of which is silvered, to prevent, as much as possible, the corrosion of the oil or other lubricating mixture, and also affords a supply of several weeks' duration.

The recording-apparatus (which may be fixed at any distance from the velocity- or cup-apparatus, thus enabling observers to overcome the difficulties at present experienced, arising from the interference of buildings, trees, and undulatory surfaces of land) consists of a train of wheels and pinions working in a frame, or

between two brass plates, the arbors of which project through a dial-plate, whereon the circles and figures are engraved, and carry the hands. These wheels are driven by a weight attached to a brass wheel or pulley, working on a double silk-line wound round a barrel to which the driving-wheel is attached; and a locking-pin disk, the pinion of which works in the first or one-mile wheel, is released at every contact of the cup-apparatus by an electro-magnet, which unlocks the pin-disk and allows the first hand to advance $\cdot 05$ mile on the graduated dial, by a jump similar to the minute-hand in remontoire clocks. By turning "on" a "strike-silent" stop, at the bottom of, and projecting from the dial-plate, a hammer lever is brought into connexion with the escapement, and strikes a bell at every contact; therefore the observer, in noting interval-velocities, may confine his visual attention to the seconds-hand of his watch or chronometer—a centre or split-seconds, or chronograph would be preferable—while he counts the number of times that the bell is struck, each of which corresponds to $\cdot 05$ mile. I have calculated and arranged a very comprehensive series of Tables (consisting of factors, by which to multiply the number of beats observed, to deduce at once the hourly velocity, also wind-velocities and their corresponding pressures) for use with this instrument.

The following formula will serve to deduce the hourly velocity from observations during intervals of minutes and seconds. Let T be the interval of observation in the min. and sec. expressed decimally, shown by the watch or chronometer, and x the number of times T is contained in one hour, b number of beats on bell, $\cdot 05$ unit of distance measured, and V velocity required; then

$$\frac{60}{T} = x,$$

therefore

$$x \times b \times \cdot 05 = V.$$

Therefore, supposing the bell is struck fifteen times in 1.5 min. the hourly velocity will be

$$x = \frac{60}{1.5} = 40;$$

therefore

$$V = 40 \times 15 \times \cdot 05 = 30 \text{ miles}$$

By noticing the exact seconds upon which the first and last

beats are struck, the results will be as accurate as if the instrument were capable of recording the one-thousandth part of a mile, while the battery power is less called into action. In noting velocities extending over long periods of time, the instrument is read in the same manner as the ordinary cup and dial anemometer, or as a gas-meter*.

In addition to the advantages attained in this instrument, which I have already mentioned, there are others, of which it will suffice that I should mention one in particular, viz. what I may term the distribution of motive power, as follows:—the cups have practically nothing to do but to overcome their own friction and turn the contact-disk. The magnet is only required to liberate the train by unlocking a double-pallet lever escapement, the lower pallet of which is placed in advance of the upper, and serves the purpose of detaining the locking-pins in the event of the cups remaining in contact during a calm. When the circuit is broken, the pallet-lever falls, and the pin, previously held by the lower, is transferred to the upper pallet, ready to be released at the next contact. It must be distinctly understood that during the time a pin rests on the lower pallet, and also while it is transferring itself to the upper pallet, no additional velocity is registered, the next .05 mile having but just commenced, although the one-mile hand is seen to advance a little, but only to take up its true position for the last registration, which it fell slightly short of during the contact. The escapement works with great nicety, being fitted with a *contracting* spiral spring and adjusting screws. Lastly, the train of wheels, locking-disk, and hands are driven by a weight, which would also form the motive power for a travelling-pencil in connexion with the proposed clockwork drum.

The recording-instrument requires winding once for every 2800 miles.

The electro-magnet is worked by the *Leclanché* battery, which consists of porous cells filled with peroxide of manganese, and plunged into a saturated solution of sal-ammoniac contained in outer glass jars, or wide-mouthed bottles, in which bars of zinc are placed as the second element.

* A plan was shown by Mr. Hall by which a continuous registration might be effected on metallic paper clamped on a drum revolving by clockwork.

XXXVIII. *Results of Meteorological Observations taken at the Observatory, Adelaide, South Australia, lat. 34° 57' S., long. 138° 38' E., height above the sea-level 140 ft. By CHARLES TODD, F.R.A.S., Superintendent of Telegraphs, and Government Observer.*

Year.	Pressure of Atmosphere in Year.					Temperature of the Air in Year.										Hygro- meter.		Cloud.		Rain.					
	in. 29.908	in. 29.864	in. 30.461	in. 29.267	in. 1.164	Highest.	Lowest.	Range.	Mean Daily	Mean of Dry. bulb, 9 A.M.	Mean of Dry. bulb, 6 P.M.	Mean of Wet. bulb, 9 A.M.	Mean of Wet. bulb, 6 P.M.	Mean of Wet. bulb, 9 A.M.	Mean of Wet. bulb, 6 P.M.	Air. Mean Temperature of	Mean Temperature of Dew-point.	Baric force of Vapour.	Mean Degree of Humidity (Sat.=100).	9 A.M.	6 P.M.	Mean Low Night Temperature.	Number of Days it fell	Amount collected	
1862	29.908	29.864	30.461	29.267	1.164	115.0	35.3	79.7	75.8	84.6	64.6	20.7	68.4	68.2	67.1	66.6	65.0	49.5	57	4.5	8.3	4.5	0	119	21.85
1863	860	843	419	150	269	110.2	33.0	77.2	74.2	84.1	64.1	20.1	65.4	63.9	66.2	65.8	64.2	49.4	59	5.2	8.2	4.5	48.4	145	23.68
1864	945	898	838	233	263	110.0	39.0	71.0	75.8	83.4	62.4	21.4	64.7	63.2	65.5	65.1	63.1	48.7	60	5.1	4.5	46.1	111	19.09	
1865	950	912	803	212	291	113.5	36.0	77.5	74.3	81.9	61.9	22.4	65.2	63.5	65.2	64.3	63.1	47.9	58	4.9	4.1	45.8	108	15.61	
1866	945	899	472	245	227	109.5	37.2	73.3	74.3	83.6	63.6	20.7	64.7	63.6	65.8	65.3	64.0	48.6	57	4.9	4.4	47.3	115	20.11	
1867	912	867	492	296	266	112.5	36.6	76.7	73.8	83.1	63.1	20.7	64.6	63.2	65.4	64.7	63.6	49.0	59	4.9	4.2	47.5	113	19.06	
1868	959	914	817	368	149	110.6	34.5	76.1	73.7	83.2	63.2	20.6	64.2	63.3	64.9	64.7	63.0	48.2	54	4.9	4.7	47.8	114	19.99	
1869	29.947	29.892	30.497	29.195	1.302	113.0	36.2	76.6	73.8	83.6	63.6	20.7	63.5	63.2	64.5	64.3	63.0	46.9	56	5.2	4.3	49.8	123	14.74	
Mean	29.823	29.865	30.436	29.225	1.261	111.8	35.9	75.9	74.1	83.2	63.6	20.9	64.6	63.6	65.6	65.1	64.0	48.5	58	5.1	4.4	47.5	119	19.26	

[Price Two Shillings.]

Vol. V.]

[No. 55.

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1871, APRIL 19.

CONTENTS.

Communications made at the Ordinary Meeting:—

XXXIX. On Deep-Sea Thermometers.—Captain J. E. Davis, R.N., F.R.G.S. (One Plate and three Woodcuts).....	Page 305
---	-------------

Correspondence, &c.:—

À M. le Président de la Société Météorologique.—P. F. Denzas, Hon. Mem. M.S.	343
--	-----

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1871, June.

ADVERTISEMENTS.

This day is published, price 4s.

INTRODUCTORY TEXT-BOOK OF METEOROLOGY.

By ALEXANDER BUCHAN, M.A., F.R.S.E.,
Secretary of the Scottish Meteorological Society; Author of 'Handy Book of
Meteorology,' &c.

Crown 8vo, with Eight coloured Charts and other Illustrations.

WILLIAM BLACKWOOD and Sons, Edinburgh and London.

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb
Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Hours of
Observation, for different Ranges of Daily Temperature, with similar Corrections for the
Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

"Those who desire correct information on the best means of observing Meteorological
phenomena, will find what they require in Mr. BELVILLE's Books."—*Athenæum*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal
Society, &c., Red Lion Court, Fleet Street, E.C.

ADVERTISEMENTS are requested to be sent to the Publishers, Messrs. TAYLOR
and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line. .	0	0	6	Bills, half-sheet and less. .	1	10	0
Half a page	0	17	6	„ whole sheet	2	0	0

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.]

1871, APRIL 19.

[No. 55.]

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

Barber, Samuel, *The Lyceum, Liverpool*;
Tyrer, Richard, *Grove House, Mansfield, Notts.*;
were balloted for and duly elected Fellows of the Society.

XXXIX. *On Deep-Sea Thermometers.* By Captain J. E. DAVIS, R.N., F.R.G.S.

THE objects of this paper and of the experiments and observations recorded therein, are :—

1. The ascertainment of the effect of pressure on thermometers used for deep-sea purposes.
2. To obtain a scale whereby observations made by the thermometers now in use could be corrected for pressure.
3. To obtain a scale whereby observations made previously by other thermometers can be utilized.

In the early part of the year 1868 the attention of the Hydrographer of the Navy was directed to the unsatisfactory nature of the deep-sea Six's thermometers then in use, and it was pointed out to him that, so far as those who had had experience could judge, we had retrograded in the construction rather than advanced; but as one of early make (such as were used by Sir James Ross in 1840) could not be procured, no actual comparison could be made.

The self-registering thermometer known as "Six's," invented by Mr. James Six, of Canterbury, was described by him in the 'Philosophical Transactions' of the Royal Society in 1782; but as the description, as recorded in those 'Transactions,' is by no means clear in regard to the principle on which the thermometer is constructed, but dwells rather on its mode of self-registering (which was the *point* of the invention), it may not be out of place here, when recording observations and experiments made with this truly valuable instrument, to append a brief description of it.

As originally made, it consisted of a long cylindrical bulb united to a smaller tube of more than twice its length, bent up and down in the form of a siphon with the cylinder in the centre, and terminating in a small oval bulb at the top,—the lower portion of the siphon being filled with mercury, the long bulb, the other parts of the tube, and about a third of the small bulb with rectified alcohol, the remaining part of the small bulb being filled with highly compressed air, which acts as a spring to compress the mercury and cause it to rise in the opposite tube, on the contraction (from cold) of the spirit.

A steel bar enclosed in glass, with flattened projecting glass ends, is enclosed in each limb of the siphon above the mercury, the flattened end preventing the mercury from passing them: these, from their weight, would rest on the mercury; but each has a fine hair tied to its upper extremity and bent against the interior of the tube, to act as a spring with sufficient elasticity to keep the bar or index supported in the spirit, while the application of a horse-shoe magnet close to the glass, will draw them down to the surface of the mercury in each stem.

Without altering the principle, a modification in the form has since been made; thus, instead of the long cylindrical bulb in the centre a bulb filled with spirit is joined to the upper end of the siphon, abreast of, but rather lower than, the opposite bulb. By this arrangement the instrument is made more compact, and its strength increased by lessening the number of bends, thus better adapting it to the comparative rough usage it has to be subjected to when used for deep-sea purposes.

On a rise of temperature, the spirit in the bulb will expand and depress the mercury in one stem, while it raises it in the other, carrying with it the index, whilst a return of cold will contract the spirit in the bulb, allowing the elastic force of the compressed air to depress the mercury in the opposite stem and raise it in the

other, each index retaining its position at the extreme of heat and cold attained, while the top of the mercury in each limb denotes the temperature of the time being. It will be observed that the cold is indicated at the upper end of the one stem, and heat at the upper end of the other, and the scales or graduations thus become reversed.

The objections made to these thermometers were:—

1. Their fragility, the slightest jar or blow often breaking them.
2. The necessity of their being always kept in a vertical position.
3. The uncertainty of the register, the indices being generally capable of being shaken down.
4. Their large size, in connexion with friction in passing through the water.
5. The substance they were mounted on, being generally wood, became so swollen by pressure of the water as often to render them incapable of being withdrawn from the case.

It was also considered that in all thermometric observations at great depths we had been "working in the dark," in that we had no idea of the effect pressure had on the instrument, and consequently on the recorded results; and it was reasonable to suppose that as the action of a thermometer was affected *in vacuo*, an opposite effect would be had by placing them under pressure, the more especially as in the one case the pressure of only one atmosphere, or 15 lbs. to the square inch, was removed, while in the other the atmospheres would have to be reckoned by hundreds and the pressure by tons. On this point we were not without actual observation; for Mr. Glaisher, during the year 1844, in some experiments made on the temperature of the Thames near Greenwich with delicately constructed instruments, found that the indications of temperature were affected by pressure on the bulb of the thermometers, and that at a depth of only 25 feet, or about three fourths of an atmosphere, the readings were increased by 2°; but no definite conclusion could be arrived at from these observations in respect to our deep-sea thermometers, beyond the fact that they were liable to be so affected.

It was therefore suggested to the Hydrographer—

1. That the author might be placed in personal communication with different makers in respect to the best construction for the purpose required, and

2. That a series of experiments should be made by placing some

thermometers in an hydraulic press in conjunction with one in an hermetically sealed iron bottle (as a standard) and subjecting them to pressure, that they should be kept under pressure sufficient time to allow the thermometer within the bottle to take up the temperature without, and then the whole compared with the standard.

The first suggestion was immediately acceded to; and those makers from whom the Meteorological Department obtained instruments (viz. Messrs. Elliot, 449 Strand, Mr. Casella, Hatton Garden, and Messrs. Negretti and Zambra, Hatton Garden) were applied to, and the following desiderata submitted to each.

Desiderata for Deep-sea Mercurial Thermometers.

1. That they could not be injured by being placed in a horizontal position or even in a reversed position and shaken*.
2. That the bulbs should be entirely protected†.
3. That the ends of the indicators should be made so exact to the diameter of the tube that there could be no possibility of globules of mercury getting above the end.
4. That the indicators should be made so stiff with the frictional hairs that no vibration, shaking, or tapping, could possibly move them.
5. That the plate on which the scale is marked should be made only sufficiently wide for the scale, and also that it should be made so that the tubes could be sunk in it to one-half their diameter, thus bringing the indicator on a level with the scale and avoiding error by parallax in reading off.
6. That between the brasses (which fix the tube to the plate) and the tube a piece of wash-leather should be inserted, to prevent breakage by a jar‡.
7. The range of temperature necessary for ocean observations (and all that need be made visible on the scale) is from $+20^{\circ}$ to 100° .
8. Small size.
9. Lowness of price§.

* Much stress was laid on this point, as it is almost impossible to keep them always in a vertical position on shipboard.

† This protection was intended merely to enable the instrument to be handled with more safety than it could be without.

‡ As many thermometers had been broken at these points, it was concluded that this trifling omission had been the cause.

§ This was explained as not being intended to beat the maker down, or to get an inferior instrument, but to enable more to be used for observing with.

10. The use of wood in mounting to be discontinued. The Hydrographer suggested ebonite for mounting thermometers on; this was adopted and found to answer.

Subsequently Mr. Pastorelli, 208 Piccadilly, expressed a wish to make some for trial; this was complied with; but as Messrs. Negretti and Zambra did not respond to the request, the number of makers was still confined to three; and six thermometers were ordered from each. These instruments were sent in (hereafter called the Hydrographic-Office pattern), and Mr. Balfour Stewart, of the Observatory at Kew, was consulted as to the *modus operandi* of testing by pressure; and he approved of that already suggested.

A difficulty arose in respect to a hydraulic press: the use of some in London could not be obtained; and others were not adapted to the purpose; so that the testing was deferred, and some of the instruments were sent to H.M.S. 'Gannet,' then deep-sea sounding on the edge of the Gulf-Stream, and afterwards some to H.M.S. 'Lightning' for her dredging cruise.

On the return of these vessels, the conflicting nature of the temperatures obtained from those supposed to exist (as derived from observations in other localities) rendered the necessity of ascertaining the nature and amount of error due to pressure the more imperative.

At this juncture Mr. Casella (being much interested, although believing that pressure would neither affect the thermometers nor their results) undertook to have a testing-apparatus constructed at his own expense, capable of producing a pressure of three tons to the square inch. This hydraulic testing-apparatus was made by Messrs. Kittoe and Brotherhood, Engineers and Millwrights, Clerkenwell.

At a meeting of the Committee of the Royal Society, held in the Hydrographer's Room in April 1869, and at which all the appliances relating to deep-sea sounding were placed before them, the plan of operation for testing the thermometers was discussed, and that by means of an iron bottle approved. Dr. Miller, V.P.R.S., proposed encasing the full bulb in an outer covering of glass containing air, in order to permit the lighter fluid (air) to be compressed without affecting the bulb within: and one such was directed to be made; but instead of the outer casing being filled with air, it was nearly filled with alcohol, which being heated to reduce the quantity of air, the bulb was then hermetically sealed. Mr. Casella was also directed to make others that would facilitate the observations.

At the time these experiments were proposed, it was not known that a thermometer had been constructed at the suggestion of Mr. Glaisher, by the late Admiral FitzRoy's directions, with the view of removing the difficulty of pressure; this was done by encasing the long bulb at the back of the instrument in glass, and nearly filling the space between the case and the bulb with mercury*; and one on this principle was then in the Instrument-room of the Meteorological Office; but although some had been used for deep-sea purposes, the further issue of them had been stopped on account of their fragility, and thus the means for obtaining accurate observations were virtually the same as before.

During the delay caused by the want of an hydraulic press, a Committee of the Royal Society was appointed to direct the investigation of the ocean observations since so successfully carried out in H.M. Ships 'Lightning' and 'Porcupine,' and the proposal by Dr. Miller to encase the full bulb, recorded above, was made without the knowledge of such a one having been previously made; but as it differed in form, it has been called the "Miller pattern" to distinguish it.

It was decided to test them at pressures equal to the following depths in the ocean, viz. 250, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, and 2500 fathoms, the rule to be applied being 33 feet = one atmosphere = 15 lbs. on the square inch. From this the following Table was constructed for use:—

Pressure.			
Fathoms.	Atmospheres.	lbs.	tons.
250	45·5	682	0·30
500	90·9	1363	0·61
750	136·4	2045	0·91
1000	181·8	2726	1·21
1250	227·3	3408	1·51
1500	272·7	4089	1·82
1750	318·2	4771	2·12
2000	363·6	5452	2·43
2250	409·1	6134	2·74
2500	454·5	6817	3·05

On the 3rd of May the hydraulic testing-apparatus, or press, was placed in the back yard of Mr. Casella's house, against a wall which screened it from the sun, and it was tested to two tons pressure.

The next day the following thermometers were taken to Hatton Garden, viz.:—

* See Meteorological Report, No. 1, 1857.

Nos. 56 and 57 Casella... Hydrographic Office pattern.

66 and 67 Elliott ... " " "

72 and 73 Pastorelli " " "

No. 1..... Casella... Specially made with an extra-thick cylinder bulb to *defy* compression.

3..... " ... Spherical bulb; extra-thick glass. This thermometer was made, at the special request of one of Mr. Casella's workmen, in order to resist effect by pressure.

4..... " ... Short cylinder bulb; extra-thick glass.

6..... " ... A glass cup fitting over bulb, designed by Mr. Siemens.

All the above were Six's thermometers with the bulbs unprotected.

No. 2..... Casella... Glass-encased bulb, as proposed by Dr. Miller, but with the case nearly filled with spirit.

5..... " ... Long cylinder bulb at the back, encased in glass, and nearly filled with spirit.

These instruments were first compared in air and then immersed in a tub of water, No. 57 being placed in an iron bottle. Set the indices and placed the thermometers in the cylinder of the press, and pumped on a pressure equal to 250 fathoms, and kept it on two hours, when Dr. Miller and Dr. Carpenter arrived and the pressure was removed.

It is useless to record the result of this first experiment; or it may rather be stated that the results were *nil*, except ascertaining the weak points of the process adopted; these were:—

1. The iron bottle was useless, the water having forced its way through the worms of the screw and the leather washer at the top, into the cylinder.

2. We had used too many thermometers, as difficulty was found in reading off and re-setting the indices quick enough to prevent alteration taking place before re-immersion in the cylinder.

It was therefore necessary, either that the iron bottle should be made to withstand the pressure, or some standard found to compare with, independent of it. The bottle was afterwards made tight, and burst under a pressure of about 5000 lbs. to the square inch; but as the Miller-pattern thermometer subsequently proved

so near perfection, it was decided to use that as a standard for the Hydrographic-Office pattern*.

It was also necessary to reduce the number of thermometers, and also of the readings, to a minimum.

With the view of testing the efficiency of Dr. Miller's pattern (No. 2) it was placed in the cylinder with No. 57, and subjected to a pressure of 4082 lbs. (about 1480 fathoms) for a quarter of an hour, with the following result.

EXPERIMENT No. 1 (pressure = 1480 fathoms). Dr. Miller reading.

Thermometer.	Minimum.		Maximum.		Diff. of Max.	Remarks.
	Before.	After.	Before.	After.		
2	47°5	47°5	47°5	48°0	0°5	Thermometer in tube 47°5.
57	47°5	47°5	47°5	55°0	7°5	

This experiment at once proved the efficacy of the encased bulb; and the experiment was repeated with more thermometers, with the same pressure and for the same period of time.

EXP. No. 2 (pressure = 1480 fathoms). Dr. Miller reading.

Thermometer.	Minimum.		Maximum.		Diff. of Max.	Remarks.
	Before.	After.	Before.	After.		
Encased 2	47°5	47°5	47°5	48°5	1°0	
" 5	48°0	47°5	47°4	48°3	0°9	
" 1	47°5	47°5	47°5	53°5	6°0	
" 3	48°5	48°0	47°5	56°0	8°5	
" 6	48°0	47°5	47°5	58°0	10°5	
" 57	48°0	47°5	47°5	55°0	7°5	
Phillip's alpine.	...	...	47°7	118°0	70°3	

It will be seen by this experiment that while the mean difference of the encased bulbs was only 0°·95, that of the two made to defy compression was 7°·25, that with the cover 10°·5, and the Hydrographic-Office pattern the same as in No. 1, 7°·5.

* I was not aware at that time of the existence of the enclosed Phillip's thermometer as designed by Sir William Thomson.

The "Phillip's" was an ordinary make, with a very small bulb; and the great difference shown by it proved that the amount of compression is in proportion to the thickness of the glass; but in immediate connexion with the subject the experiment clearly demonstrated two facts, viz. :—

1. That very nearly all the difference, or error, is due to pressure on the full bulb; and

2. That by encasing the bulb we have nearly a perfect instrument. This result was the more important in rendering future experiments, in a manner, independent of the iron bottle, which again failed with a new washer.

Notwithstanding the satisfactory result obtained in enabling us to decide on a thermometer for future use, it was necessary, if possible, to establish a scale whereby temperatures already taken with instruments of the Hydrographic-Office pattern might be corrected for pressure, and also to ascertain if all, or what part, of the difference shown under pressure in the Miller pattern was due to calorific effect produced by sudden compression of the water in the cylinder or by compression of the unprotected parts: preparation was accordingly made to continue the experiments.

It being necessary, as before stated, to reduce the number of the thermometers, and also the readings, to a minimum, the following were selected, viz. :—

Nos. 2 and 5	Casella...	Encased bulbs.
56 and 57	"	Hydrographic-Office pattern.
73.....	Pastorelli	" " "
67.....	Elliott ...	" " "
9641.....	Casella...	Alpine.

These were attached to a float (to avoid immersing the hand in the water) and placed in the cylinder filled with water, to remain all night; the cistern, from which the water is pumped into the cylinder, was filled, and also a tub of water for replenishing placed by the side in order that the water in each might be, as nearly as possible, of the same temperature in the morning.

As the relative readings of the maximum and minimum of each thermometer were compared in both air and water and found to agree, and as a progressive increase in the temperature of the cylinder was observed, the difference between the minimum and maximum indices is used: the maximum mercury is always recorded; but as it had not always time to adjust itself to its normal state, it can only be used as a check to the minimum readings.

The thermometers were read in the order in which they are placed; when all were read, the indices were set as quickly as possible, and the instruments at once lowered into the cylinder and the pressure applied.

May 5th the first series of experiments were made, Mr. Casella reading.

First Series of Experiments.

No. 1 (pressure = 250 fathoms = 682 lbs.). Under pressure forty minutes.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
2.....	46°5	46°1	47°6	1°5	Water in tub 45°8
5.....	46°8	46°3	47°6	1°3	" tube 48°5
56.....	46°5	46°1	47°2	1°1	
57.....	47°2	46°2	47°2	1°0	As Phillip's was not attached to a float, it could not be taken out without the insertion of the hand and the displacement of a quantity of water.
73.....	47°3	46°0	47°9	1°9	
67.....	48°2	46°1	50°0	3°9	
Phillip's } Alpine }	.....	47°0	.....	.....	

No. 2 (pressure = 500 fathoms = 1363 lbs.). Under pressure twenty-five minutes.

2.....	47°7	47°5	49°6	2°1 ?	Water in tub 46°4
5.....	47°8	47°8	49°4	1°6	" tube 49°0
56.....	47°2	47°2	49°9	2°7	
57.....	47°8	47°4	50°1	2°7	
73.....	47°8	47°5	50°1	2°6	
67.....	48°2	47°6	55°5	7°9	

No. 3 (pressure = 750 fathoms = 2045 lbs.). Under pressure thirty-three minutes.

2.....	49°0	48°5	49°5	1°0	Water in tub 47°2
5.....	48°5	48°6	48°8	0°2	" tube 50°0
56.....	48°4	47°8	51°6	3°8	
57.....	48°6	48°0	51°8	3°8	No. 67 was taken out safely; but while reading off, the full bulb cracked right across.
73.....	48°6	48°2	52°4	4°2	
67.....	Broken.				

No. 4 (pressure = 1000 fathoms = 2726 lbs.). Under pressure thirty-seven minutes.

2.....	50°0	49°6	50°8	1°2	Water in tub 47°8
5.....	49°6	49°5	50°1	0°6	" tube 50°8
56.....	49°6	49°5	53°8	4°3	
57.....	49°8	49°5	54°4	4°9	
73.....	49°5	49°2	55°2	6°0	

Placed another of Elliot's (No. 66) in the cylinder.

No. 5 (pressure = 1250 fathoms = 3408 lbs.). Under pressure thirty-six minutes.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
2.....	50°8	50°4	51°6	1°2	Water in tub 48°6
5.....	50°4	50°4	50°8	0°4	" tube 51°2
56.....	50°1	50°1	55°6	5°5	" cylinder 50°5
57.....	50°3	50°2	55°8	5°6	" air..... 49°2
73.....	50°3	50°2	57°0	6°8	
66.....	50°4	49°7	63°0	13°3	

No. 6 (pressure = 1500 fathoms = 4089 lbs.). Under pressure fifty minutes.

2.....	51°3	50°8	52°4	1°6	Water in tub 49°3
5.....	50°3	51°0	51°8	0°8	" tube 52°1
56.....	50°4	50°5	57°5	7°0	
57.....	50°5	50°6	58°0	7°4	
73.....	50°6	50°8	59°0	8°2	
66.....	50°9	50°5	66°9	16°4	

No. 7 (pressure = 1750 fathoms = 4771 lbs.). Under pressure thirty minutes.

2.....	51°7	51°4	52°8	1°4	Water in tub 49°6
5.....	51°0	51°5	52°3	0°8	" tube 52°4
56.....	51°0	51°0	59°0	8°0	" cylinder 51°2
57.....	51°0	51°0	59°2	8°2	
73.....	50°6	51°0	60°7	9°7	
66.....	51°0	50°8	69°5	18°7	

Placed one of Thomson's insulated thermometers in the press.

No. 8 (pressure = 2000 fathoms = 5452 lbs.). Under pressure thirty minutes.

2.....	52°0	51°9	53°5	1°6	Water in tub 49°6
5.....	51°1	51°6	53°2	1°6	" tube 52°4
56.....	51°0	51°1	60°6	9°5	" cylinder 51°7
57.....	51°1	51°3	61°0	9°7	
73.....	51°2	51°4	61°6	10°2	
66.....	Broke at a pressure equal to 1848 fathoms.				
Phillip's 9641... }	.....	.....	118°0	71°0	
Thompson*	.....	51°0	52°1	1°1	

* This insulated thermometer is a Phillip's encased in a glass cylinder containing a little spirit, designed by Sir William Thomson.

As the pressure was being pumped on in the last experiment, heard a sharp crack when the gauge indicated a pressure of $2\frac{1}{4}$ tons: the sound was so loud that it was heard in the house. On taking the instruments out, No. 66 was found to be completely smashed, and must have broken in several places at the same moment.

May 6th.—The following experiment was made with the Hydrographic-Office pattern (not used yesterday) for comparison. Mr. Casella reading.

Pressure = 2000 fathoms = 5452 lbs. Under pressure
seventeen minutes.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
2.....	53°6	53°5	54°9	1°4	Water in tub 51°9
5.....	53°5	53°6	54°8	1°2	„ tube 55°4
53.....	53°2	53°1	63°0	9°9	„ cylinder 53°5
58.....	53°7	52°6	63°3	10°7	
71.....	53°5	53°0	64°3	11°3	
74.....	53°5	53°2	63°5	10°3	
75.....	54°9	53°2	62°8	9°6	
Thompson	.....	55°2	56°2	1°0	

The results of the first series of experiments are presented graphically in the annexed diagram (Plate V.).

Second Series of Experiments.

June 21st.—The thermometers were placed in the cylinder, which was filled with water; the supply-tub or cistern for pumping in from, and a tub of water standing near the press, were also filled and thus left all night.

June 22nd.—A dull morning, with no sun, all the conditions most favourable for observing.

Before commencing, obtained two tubs of water with 12° difference of temperature (determined with a delicate thermometer), and, to ascertain the time required by one of the Miller pattern to take up temperature, removed one suddenly from one tub to the other (from the cold to the warmer) and then back.

To take up 12° of heat it took seven minutes; the first 6° (as might be expected) were taken up more rapidly than the second.

To lose the same amount of heat, by being placed in the colder water, it took only four and a half minutes.

It was therefore concluded that by allowing the thermometers to remain under pressure eight minutes, the same results would be obtained as if allowed to remain half an hour or more, as in the first series of experiments.

The thermometers used were :—

Standard..... Casella..... Dr. Miller's pattern.

No. 54..... " Hydrographic-Office pattern.

56..... " " " "

76..... Pastorelli ... " " "

78..... " " " "

Thompson ... Casella..... Encased (Sir William Thomson's design).

All under pressure 8 minutes.

No. 1. Pressure =250 fathoms =682 lbs.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
Standard ...	53°6	53°3	54°0	0°7	Temperature of air..... 55°8
54.....	53°8	53°3	54°7	1°4	Water in tub 54°4
56.....	53°8	53°2	55°0	1°8	" cistern..... 53°0
76.....	54°2	53°8	55°0	1°2	" tube..... 54°4
78.....	53°8	53°5	54°9	1°4	" cylinder 54°4
Thomson...	54°4	.....	54°4	0°0	

No. 2. Pressure =500 fathoms =1863 lbs.

Standard ...	54°3	53°8	54°5	0°7	Temperature of air..... 56°7
54.....	54°2	53°6	56°7	3°1	Water in tub 54°5
56.....	54°0	53°7	56°5	2°8	" cistern..... 54°0
76.....	54°5	54°3	56°8	2°5	" tube..... 54°6
78.....	54°0	53°8	56°8	3°0	" cylinder 54°9
Thomson...	53°9	.....	54°0	0°1	

No. 3. Pressure =750 fathoms =2045 lbs.

Standard ...	54°6	53°8	55°0	1°2	Temperature of air..... 57°2
54.....	54°2	53°9	57°8	3°9	Water in tub 54°6
56.....	54°2	53°8	57°8	4°0	" tube..... 54°6
76.....	54°9	54°3	58°5	4°2	" cistern..... 54°7
78.....	54°2	53°9	58°5	4°6	" cylinder 54°9
Thomson...	54°6	.....	54°6	0°0	

No. 4. Pressure = 1000 fathoms = 2726 lbs.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
Standard ...	54°9	54°1	55°6	1°5	Temperature of air..... 58°7
54.....	54°6	54°0	59°2	5°2	Water in tub 54°9
56.....	54°2	53°8	59°1	5°3	" cistern..... 55°1
76.....	55°0	54°6	59°5	4°9	" tube..... 55°0
73.....	54°7	54°1	59°0	4°9	" cylinder 54°9
Thomson...	54°3	.....	54°6	0°3	

No. 5. Pressure = 1250 fathoms = 3408 lbs.

Standard ...	55°2	54°2	55°8	1°6	Temperature of air..... 60°0
54.....	54°9	53°9	60°3	6°4	Water in tub 55°0
56.....	54°9	54°0	60°3	6°3	" cistern..... 55°6
76.....	55°5	54°7	61°0	6°3	" tube 55°3
73.....	55°0	54°3	61°7	7°4	" cylinder 55°6
Thomson...	54°8	.....	54°9	0°1	

No. 6. Pressure = 1500 fathoms = 4089 lbs.

Standard ...	55°5	54°8	56°3	1°5	Temperature of air..... 61°0
54.....	55°0	54°2	62°0	7°8	Water in tub 55°1
56.....	55°3	54°3	62°1	7°8	" cistern..... 55°8
76.....	55°9	55°0	62°5	7°2	" tube..... 55°8
73.....	55°4	54°7	62°5	7°8	" cylinder 55°8
Thomson...	54°8	.....	55°3	0°5	

No. 7. Pressure = 1750 fathoms = 4771 lbs.

Standard ...	55°9	55°2	56°9	1°7	Temperature of air..... 62°0
54.....	55°2	55°0	63°3	8°3	" tub 55°0
56.....	55°5	54°8	63°6	8°8	" cistern..... 56°3
76.....	56°1	55°7	64°1	8°4	" tube..... 56°1
73.....	55°8	55°0	65°2	10°2	" cylinder 55°9
Thomson...	55°1	.....	55°4	0°3	

No. 8. Pressure = 2000 fathoms = 5452 lbs.

Standard ...	56°2	55°5	57°5	2°0	Temperature of air..... 62°4
54.....	55°7	55°5	65°2	9°7	Water in tub 55°6
56.....	55°9	55°2	65°1	9°9	" cistern..... 57°0
76.....	56°8	55°9	65°5	9°6	" tube..... 56°5
73.....	56°4	55°4	66°9	11°5	" cylinder 56°3
Thomson...	55°6	.....	56°2	0°6	

No. 9. Pressure = 2250 fathoms = 6134 lbs.

Thermo- meter.	Max. Mercury.	Min. Index.	Max. Index.	Diff.	Remarks.
Standard ...	56°5	55°9	57°9	2°0	Temperature of air..... 63°4
54.....	56°3	55°4	66°5	11°1	Water in tub 56°0
56.....	56°3	55°5	66°4	10°9	" cistern..... 57°8
76.....	57°2	56°3	67°2	10°9	" tube..... 57°0
73.....	56°8	56°0	68°3	12°3	" cylinder 57°0
Thomson...	55°9	.....	56°7	0°8	

No. 10. Pressure = 2500 fathoms = 6817 lbs.

Standard ...	57°1	56°5	58°7	2°2	Temperature of air..... 63°6
54.....	56°7	55°4	68°3	12°9	Water in tub 56°0
56.....	56°4	55°9	67°9	12°0	" cistern..... 58°0
76.....	57°4	56°9	68°6	11°7	" tube..... 57°5
73.....	56°9	56°3	70°0	13°7	" cylinder 57°0
Thomson...	56°7	.....	57°1	0°4	

NOTE.—While conducting these experiments we caught a small water-worm in the water-tub, placed it in a tube and tied a piece of rag over it, and placed it in the cylinder, subjecting it to a pressure of 3408 lbs. for 8 minutes; it came out alive. Repeated the experiment with a pressure of 4089 lbs. for the same time; after a little time it showed signs of life. Again repeating the experiment with a greater pressure, the bottle was broken and the worm lost by the accident.

The results of the second series of experiments are laid down in the diagram annexed (Plate V.).

TABLE showing the progressive difference for each 250 fathoms by each Thermometer.

By First Series of Observations.

Pressure equal to Fathoms.	2.		5.		Casella.				Pastorelli.	
					56.		57.		73.	
	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.
0	0	0	0	0	0	0	0	0	0	0
250	1'5	+1'5	1'3	+1'3	1'1	+1'1	1'0	+1'0	1'9	+1'9
500	1'1	-0'4	1'6	+0'3	2'7	+1'6	2'7	+1'6	2'6	+0'7
750	1'0	-0'1	0'2	-1'4	3'8	+1'1	3'8	+1'1	4'2	+1'6
1000	1'2	+0'2	0'6	+0'4	4'3	+0'5	4'9	+1'1	6'0	+1'8
1250	1'2	0'0	0'4	-0'2	5'5	+1'2	5'6	+0'7	6'8	+0'8
1500	1'6	+0'4	0'8	+0'4	5'5	+1'5	7'4	+1'8	8'2	+1'4
1750	1'4	-0'2	0'8	0'0	7'0	+1'0	8'2	+0'8	9'7	+1'5
2000	1'6	+0'2	1'6	+0'8	8'0	+1'5	9'7	+1'5	10'2	+0'5
Mean diff. per 250 fathoms }	.....	+0'20	.....	+0'20	.....	+1'19	.....	+1'20	.....	+1'27

By Second Series of Observations.

Pressure equal to Fathoms.	Standard.		Casella.				Pastorelli.				Thomson.	
			54.		56.		76.		73.			
	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.	First diff.	Second diff.
0.....	0	0	0	0	0	0	0	0	0	0	0	0
250.....	0'7	+0'7	1'4	+1'4	1'8	+1'8	1'2	+1'2	1'4	+1'4	0'0	+0'0
500.....	0'7	0'0	3'1	+1'7	2'8	+1'0	2'5	+1'3	3'0	+1'6	0'1	+0'1
750.....	1'2	+0'5	3'9	+0'8	4'0	+1'2	4'2	+1'7	4'6	+1'6	0'0	+0'1
1000.....	1'5	+0'3	5'2	+1'3	5'3	+1'3	4'9	+0'7	4'9	+0'3	0'3	+0'3
1250.....	1'6	+0'1	6'4	+1'2	6'3	+1'0	6'3	+1'4	7'4	+2'5	0'1	-0'2
1500.....	1'5	-0'1	7'8	+1'4	7'8	+1'5	7'2	+0'9	7'8	+0'4	0'5	+0'4
1750.....	1'7	+0'2	8'3	+0'5	8'8	+1'0	8'4	+1'2	10'2	+2'4	0'3	-0'2
2000.....	2'0	+0'3	9'7	+1'4	9'9	+1'1	9'6	+1'2	11'5	+1'3	0'6	+0'3
2250.....	2'0	0'0	11'1	+1'4	10'9	+1'0	10'9	+1'3	12'3	+0'8	0'8	+0'2
2500.....	2'2	+0'2	12'9	+1'8	12'0	+1'1	11'7	+0'8	13'7	+1'4	0'4	-0'4
Mean diff. per 250 fms.	} ...	+0'22	.....	+1'29	.....	+1'20	.....	+1'17	.....	+1'37	.....	+0'05

Experiments for Calorific Effect.

The Phillip's encased maximum thermometers (Thompson's) being entirely protected from any effect by compression, it was decided to ascertain by their means the calorific effect produced by the sudden compression of the water in the cylinder; but, as will be seen by glancing through the two series of experiments recorded, there was such a gradual increase in the temperature of the air and also in the water used for supplying the cylinder, that for any delicate observation the conditions were not favourable; the observations for calorific effect were therefore delayed until the weather got colder, when a more equable temperature could be ensured throughout the experiment.

In order to ascertain what time it would require for these instruments to take up temperature (as it was of importance they should not be kept under pressure longer than necessary) the following observations were made, viz.:—

Compared two Thomson's thermometers (Nos. 9640 and 9647) in the air with a delicate thermometer (No. 2528); all agreed.

Placed the three thermometers nearly in a horizontal position in a deep dish containing water (temperature $65^{\circ}4$); when all agreed, set the indices, replaced them in the water, the bulbs of the three being near together, poured in a little warm water at the furthest side from the bulbs, agitated the water with a pencil, and watched, with a magnifier, the effect. The mercury of the encased thermometers commenced rising almost as soon, and as quickly, as the plain, taking from 1 to 3 minutes to attain from two to three degrees, to the exact temperature of the water: this experiment was repeated several times and with the same results.

Poured in a quantity of warm water with the following results.

From 71.5 to $75.0 = 3.5$	it took	$\begin{array}{r} \text{m} \\ 0 \end{array}$	$\begin{array}{r} \text{s} \\ 15 \end{array}$
„ 75.0 to $80.0 = 5.0$	„	$\begin{array}{r} 0 \\ 45 \end{array}$	
„ 80.0 to $81.3 = 1.3$	„	$\begin{array}{r} 1 \\ 0 \end{array}$	
„ 81.3 to $81.7 = 0.4$	„	$\begin{array}{r} 3 \\ 0 \end{array}$	
Total time of rising $10^{\circ}2$		$\begin{array}{r} 5 \\ 0 \end{array}$	

This was an outside period of time, or until a retrograde movement of the mercury was observed as the water cooled: it was therefore considered that 5 minutes would be sufficient time for the Thomson thermometers to take up the most minute portion of heat observable.

For the purpose of observing this heat engendered by pressure, a Six's unprotected thermometer was made by direction of one of the Committee of the Royal Society, having the partially filled bulb open at the top, with a lip to which was firmly secured by wire a small piece of india-rubber tubing closed at the end, with the view of equalizing the pressure on both columns of mercury, and thus recording the amount of heat due to calorific effect only. A small portion of the mercury on the maximum side was oxidized; but it did not affect the reading, as it attained the same level on the scale of temperature as the minimum.

November 12th.—The following observations were made, day cloudy, all the conditions favourable, Mr. Casella reading:—

No. 1. Pressure = 2500 fathoms = 6817 lbs. Under pressure ten minutes.

Thermometer.	Before.	After.	Diff.	Remarks.
11424.....	37°8	37°9	+0°1	Temperature in air 40°0
9649.....	37°6	38°0	+0°4	„ tub..... 41°6
9645.....	37°7	37°9	+0°2	„ cistern . 38°8
Committee...	38°0	Broken.		„ cylinder 38°0

Heard a crack at 1200 lbs. pressure; on taking the instruments out, found the Committee thermometer broken: the bulb to which the india-rubber tubing was attached was broken off below the bulb; and the tube of the thermometer on the minimum side was broken in one place, and the minimum indicator forced up to the bulb.

Experiment No. 2 (same pressure). Under pressure twenty minutes.

Thermometer.	Before.	After.	Diff.	Remarks.
11424.....	38°8	38°8	0°0	Temperature in air 43°6
9649.....	38°8	38°8	0°0	„ tub..... 41°2
9645.....	38°6	38°4	-0°2	„ cistern . 41°2
				„ cylinder 38°9

It will be observed that the water pumped into the cylinder was a little warmer than that in the cylinder; but as the valve

through which it passed into the cylinder is near the top, while the bulbs of the thermometers were at the bottom, the small difference it could have made in the upper water could not have affected them.

By Mr. Casella (previously observed).

Thermometer.	Pressure.	Before.	After.	Diff.	Remarks.
	fms.	°	°	°	
	500	53.5	53.7	+0.2	
	1000	54.0	54.0	0.0	
	1500	54.5	54.5	0.0	
	2000	54.9	55.1	+0.2	

From Meteorological Office.

	2000	60.5	61.1	+0.6	
	2000	61.0	61.3	+0.3	

TABLE showing the result of the foregoing Experiments.

N.B. The figures in antique type are rejected in forming the mean.

Difference.	Pressure.	Per 250 fms.	Difference.	Pressure.	Per 250 fms.
°	fms.	°	°	fms.	°
+0.0	250	0.000	0.4	2500	0.040
0.1	500	0.050	0.2	2500	0.020
0.0	750	0.000	0.0	2500	0.000
0.3	1000	0.075	0.0	2500	0.000
0.1	1250	0.020	-0.2	2500	0.000
0.5	1500	0.083	+0.2	500	0.100
0.3	1750	0.043	0.0	1000	0.000
0.6	2000	0.075	0.0	1500	0.000
0.8	2250	0.089	0.2	2000	0.025
0.4	2500	0.040	0.6	2000	0.075
0.1	2500	0.010	0.3	2000	0.037

Mean 0.0178, calorific effect for each 250 fathoms' pressure.

" 0.18 " " 2500 " "

It would seem almost unnecessary, for the purpose for which this paper is prepared, to record the above observations at all, so small is the result; but as the amount of heat caused by compression is supposed by some to be much greater, it has been thought best to give the figures in full, with deductions therefrom.

Experiments to determine the amount of Heat produced by friction.

To ascertain if any error *could* arise from heat created by friction in a thermometer passing rapidly through the water, one of Casella's Hydrographic-Office pattern was towed astern of one of the fast river-steamers ('Naiad'), keeping the thermometer well submerged by means of a lead weight attached to the line before it; and with repeated trials at full speed not the slightest difference could be detected.

TABLE showing the Error of the Miller-pattern thermometer.

N.B. The figures in antique type are rejected in forming the mean.

Difference.	Pressure.	Per 250 fms.	Difference.	Pressure.	Per 250 fms.
0	fms.	0	0	fms.	0
0.5	1480	0.083	1.5	1500	0.250
1.0	1480	0.167	1.7	1750	0.243
0.8	1480	0.133	2.0	2000	0.288
1.5	250	1.500	2.0	2250	0.182
1.3	250	1.300	2.2	2500	0.220
1.1	500	0.550	1.4	2000	0.175
1.6	500	0.800	1.2	2000	0.150
1.0	750	0.333	1.5	2050	0.182
0.2	750	0.066	1.4	2050	0.170
1.2	1000	0.300	1.7	2050	0.207
0.6	1000	0.150	1.1	2050	0.134
1.2	1250	0.240	1.3	2050	0.158
0.4	1250	0.080	1.2	2050	0.146
1.6	1500	0.270	1.2	2050	0.146
0.8	1500	0.133	1.2	2050	0.146
1.4	1750	0.200	1.0	2050	0.125
0.8	1750	0.113	1.2	2050	0.146
1.6	2000	0.200	0.8	2050	0.097
1.6	2000	0.200	1.2	2050	0.146
0.7	250	0.700	1.9	2500	0.190
0.7	500	0.350	1.9	2500	0.190
1.2	750	0.400	2.0	2500	0.200
1.5	1000	0.375	1.7	2500	0.170
1.6	1250	0.320			

Error per 250 fathoms as shown by hydraulic press 0.161 mean
Deduct for calorific effect 0.018
True error per 250 fathoms 0.143
True error for 2500 fathoms 1.43

Mean Errors of Hydrographic-Office pattern Thermometers, by
testing-apparatus, corrected for Calorific effect.

Casella's Thermometers.

Fathoms...	250.	500.	750.	1000.	1250.	1500.	1750.	2000.	2250.	2500.
	° 1'1 1'0 1'4 1'8	° 2'7 2'7 3'1 2'8	° 3'8 3'8 3'9 4'0	° 4'3 4'9 5'2 5'3	° 5'5 5'6 6'4 6'3	° 7'0 7'4 7'8 7'8 7'5	° 8'2 8'2 8'3 8'8	° 9'5 9'7 9'7 9'9 9'9 10'7	° 11'1 10'9	° 12'9 12'0
Mean	1'325	2'825	3'875	4'925	5'950	7'500	8'325	9'782	11'000	12'450
Calorific effect.... }	18	36	54	72	90	108	126	144	162	180
Error	1'307	2'789	3'821	4'853	5'860	7'392	8'199	9'638	10'838	12'270

Pastorelli's Thermometers.

Fathoms...	250.	500.	750.	1000.	1250.	1500.	1750.	2000.	2250.	2500.
	° 1'9 1'2 1'4	° 2'6 2'5 3'0	° 4'2 4'2 4'6	° 6'0 4'9 4'9	° 6'8 6'3 7'4	° 8'2 7'2 7'8	° 9'7 8'4 10'2	° 10'2 9'6 11'5 10'3 10'3 9'6	° 10'9 12'3	° 11'7 13'7
Mean	1'500	2'700	4'333	5'267	6'833	7'733	9'433	10'250	11'600	12'700
Calorific effect.... }	18	36	54	72	90	108	126	144	162	180
Error	1'482	2'664	4'279	5'195	6'743	7'625	9'307	10'106	11'438	12'520

Progressive rate of Error of Hydrographic-Office pattern Thermometers, as shown by foregoing Table, by Testing-apparatus.

Casella.				Pastorelli.			
Depth.	Error.	First diff.	Second diff.	Depth.	Error.	First diff.	Second diff.
fms.	0°000	0	0	fms.	0°000	0	0
0 ...	0°000	1°307	+0°175	0 ...	0°000	1°482	-0°300
250 ...	1°307	1°482	-0°450	250 ...	1°482	1°182	+0°433
500 ...	2°789	1°032	0°000	500 ...	2°664	1°615	-0°699
750 ...	3°821	1°032	-0°025	750 ...	4°279	0°916	+0°632
1000 ...	4°853	1°007	+0°525	1000 ...	5°195	1°548	-0°666
1250 ...	5°860	1°532	-0°725	1250 ...	6°743	0°882	+0°800
1500 ...	7°392	0°807	+0°632	1500 ...	7°625	1°682	-0°883
1750 ...	8°199	1°439	-0°239	1750 ...	9°307	0°799	+0°533
2000 ...	9°638	1°200	+0°232	2000 ...	10°106	1°332	-0°250
2250 ...	10°838	1°432		2250 ...	11°438	1°082	
2500 ...	12°270			2500 ...	12°520		
			+1°574				+2°398
			-1°449				-2°798
Difference			+0°125	Difference			-0°400
Equal to an <i>increase</i> of effect at the rate of 0°·014 per 250 fathoms' pressure.				Equal to a <i>decrease</i> of effect at the rate of 0°·044 per 250 fathoms' pressure.			

It will be seen by the above Tables, that while one set of thermometers show an *increase* of effect under pressure, the other set denote a *decrease*, and the mean of the two would be so small a decrease as not to be appreciable; and the practical conclusion is, that, by the testing-apparatus, the elasticity of the glass is in exact proportion to the pressure applied.

Instructions to Staff-Commander Calver, R.N., for the Experiments to be made afloat.

" May 14, 1869.

" DEAR CALVER,—The Hydrographer having desired me to give you all the information in my power with respect to the deep-sea thermometers, it will, perhaps, be best (as you wished) for me to put my ideas in writing; at the same time I wish you to understand that I have no authority to do so, and any thing I advise must, of course, be qualified to meet the instructions given you by the Hydrographer.

" As you are aware, I have been engaged lately in making some experiments with deep-sea thermometers under pressure, by means

of an hydraulic press; and although we have, I believe, overcome the difficulty of error arising from pressure for the future, still it is of great importance to obtain a scale of error, in order to utilize observations that have been made with instruments hitherto used, which are of similar construction as those experimented with.

"By the experiments made, a scale could be formed for the above purpose; but considering that the means used to obtain that scale may be said to be made under theoretical conditions rather than practical, it necessarily needs the practical observation to verify its correctness before it can be applied, and for which purpose some of each kind will be sent on board.

"Dr. Miller's glass-encased bulb-thermometers must be accepted as standards, as from all experiments made with the press they are affected to so small a degree as not to be appreciable.

"The thermometers sent to you (with the exception of those of Dr. Miller's design, not yet sent in) are—

No. 55	Casella.....	Has not been under pressure.
58	"	Has been under pressure equal to 2000 fathoms.
58	"	" " " "
71	Pastorelli ...	" " " "
74	" ...	" " " "
75	" ...	Has not been under pressure.
68	Elliot	" " " "
69	"	" " " "
40	Pastorelli ...	Used in H.M.S. 'Gannet.'
39	" ...	" " "
41	Casella.....	" " "
42	"	" " "
48	"	" " "
38	Pastorelli ...	Used in H.M.S. 'Lightning.'

"It will be necessary not only to test the thermometers that have been under hydraulic pressure, but those also that have been used in the 'Gannet' and 'Lightning;' and I do not think a fine day would be lost if entirely devoted to these observations; and as I believe you would find a depth of 2000 fathoms about sixty miles

west from the western extreme of the Porcupine bank, perhaps if the weather promises fine when you are there, the opportunity would be a good one.

"Having ascertained the depth with a detacher, I would advise bending on just above a 56 lb. lead, and one above the other,

Standard Thermometers.

No. 53 or 58

71 or 74

39 or 40

41, 42 or 43

68 or 69—

in all, six thermometers. While obtaining the depth, place all the thermometers to be used in a bucket of surface-water placed *in the shade* and renewed occasionally from the sea.

"When the thermometers are all bent on, open the doors of the cases, set the indices quickly, read and note maximum and minimum (the standard last), and get them over the side and into the water as quickly as possible, and let them down to 250 fathoms; and allowing them to remain five minutes, heave in (very carefully as they come near the surface), read the standard first: generally the maximum index will be on the mercury, read that first, then the top of the mercury on the minimum side, and then the lowest part of the minimum index (attending to Rule 3).

"Repeat the observation, with the same instruments, at 500, 750, 1000, 1250, 1500, 1750, and 2000 fathoms, increasing the weight of sinkers as expedient.

"Form.

Thermo- meter No.	Maker.	Max. Index.	Min. Mercury.	Min. Index.	Remarks, &c.
					Surface temperature by No. .

"Although the thermometers are of such a superior construction that a shake or jar, or being placed in a horizontal or reversed position, is not liable to injure them, still, as these are

better avoided, the subjoined rules respecting them may not be out of place.

“ Rules.

“1. Keep them in a vertical position, either in the box or hanging up; if the latter, take care that in swinging they do not strike against the bulkhead.

“2. Avoid sudden shaking or jars.

“3. *If possible*, let one person always read the results, to avoid personal parallax, and, in reading, hold the instrument nearly horizontal across the face, read as near tenths of a degree as possible; and it is advisable to let a second person look at the readings, merely to check the *degree* recorded. Also let the selected reader practise.

“4. In setting the indices with the magnet, draw them down slowly, as by doing it too quickly it is liable to send a globule of mercury above the index.

“5. When the thermometers are done with for the day, rinse them in fresh water, withdraw them from their cases, wipe them gently, replace them, and place them in the box; wipe the cases well.

“6. In holding the thermometers when bending on, do not hold the case in the hand more than possible, as the heat of the hand is quickly communicated.

(Signed)

“J. E. DAVIS.”

The experiments at sea were made in strict conformity with the preceding instructions; and the results of these experiments are contained in the following Tables:—

Ocean-Observations by Staff-Commander E. K. Calver, 1869.

Casella's Hydrographic-Office pattern.

N.B. The figures in antique type are rejected in forming the mean.

250 fathoms.			500 fathoms.		
Thermo- meter.	Min. Index.	Diff. from Miller.	Thermo- meter.	Min. Index.	Diff. from Miller.
100-103 (Miller)	48°0		374 fathoms.		
53*	49°0	1°0	100-103 (Miller)	45°95	
55	49°2	1°2	55	48°4	3°27 } †
58	49°4	1°4	58	47°8	2°47 } ‡
101-103 (Miller)	48°35		500 fathoms.		
41	49°4	1°05	100-103 (Miller)	46°75	
42	49°6	1°25	53	49°0	2°25
43	49°5	1°15	55	48°8	2°05
100-103 (Miller)	48°5		58	49°0	2°25
41	49°2	0°7	101-103 (Miller)	47°5	
42	49°5	1°0	41	50°0	2°5
43	50°4	1°9	42	49°5	2°0
53	49°5	1°0	43	51°5	4°0
55	49°4	0°9			
58	50°8	2°3			
374 fathoms.			100-103 (Miller)	46°75	
100-103 (Miller)	45°95		41	48°8	2°05
55	48°4	1°64 } †	42	49°3	2°55
58	47°8	1°23 } ‡	43	49°6	2°85
			53	49°3	2°55
			55	49°0	2°25
			58	50°5	3°75
Mean.....		1°186	Mean		2°530
Correction for Miller		0°143	Correction for Miller		0°286
Error at 250 fms.		1°329	Error at 500 fms.		2°816

* An error of 1° is applied to No. 53 throughout.

† Reduced to 250 fathoms.

‡ Increased for 500 fathoms.

Ocean-Observations by Staff-Commander E. K. Calver, 1869.

Casella's Hydrographic-Office pattern (*continued*).

N.B. The figures in antique type are rejected in forming the mean.

750 fathoms.			1000 fathoms.		
Thermo- meter.	Minimum Index.	Difference from Miller.	Thermo- meter.	Minimum Index.	Difference from Miller.
100-103 (Miller)	41°2		100-103 (Miller)	38°5	
53	44°4	3°2	53	43°0	4°5
55	44°2	3°0	55	42°5	4°0
58	44°6	3°4	58	43°0	4°5
100-103 (Miller)	42°45		100-103 (Miller)	38°55	
41	46°2	3°75	41	43°8	5°25
42	46°2	3°75	42	43°5	4°95
43	46°2	3°75	43	47°0	8°45
100-103 (Miller)	42°0		100-103 (Miller)	38°8	
41	45°6	3°6	41	44°7	5°9
42	45°8	3°8	42	44°0	5°2
43	46°2	4°2	43	46°4	7°6
53	45°5	3°5	53	44°0	5°2
55	45°4	3°4	55	43°4	4°6
58	48°8	6°8	58	43°2	4°4
808 fathoms.			Mean.....		
100 (Miller)	41°4		Correction for Miller ...		
58	45°2	3°53 *	Error at 1000 fathoms...		
Mean.....		3°573	4°855		
Correction for Miller ...		0°429	0°572		
Error at 750 fathoms ...		4°002	5°427		

* Reduced for 750 fathoms.

Ocean-Observations by Staff-Commander E. K. Calvert, 1869.

Casella's Hydrographic-Office pattern (*continued*).

N.B. The figures in antique type are rejected in forming the mean.

1250 fathoms.			1750 fathoms.		
Thermo- meter.	Minimum Index.	Difference from Miller.	Thermo- meter.	Minimum Index.	Difference from Miller.
100-103 (Miller)	37°9	6°3 5°6 5°6 5°7 5°7 5°7 5°5 5°2 5°7	100-103 (Miller)	36°7	6°3 6°3 7°1 6°300 1°001 7°301
41	44°2		41	43°0	
42	43°5		42	43°0	
43	43°5		43	43°8	
100-103 (Miller)	37°3		Mean.....	6°300	
41	43°0		Correction for Miller ...	1°001	
42	43°0		Error at 1750 fathoms...	7°301	
43	43°0		2000 fathoms.		
53	42°8		100-103 (Miller)	36°3	
55	42°5		41	42°8	
58	43°0	42	43°0		
100-103 (Miller)	37°65	43	42°8		
41	42°8	5°15	Mean.....	6°567	
42	43°0	5°35	Correction for Miller ...	1°144	
43	43°0	5°35	Error at 2000 fathoms...	7°711	
Mean.....	5°571				
Correction for Miller ...	0°715				
Error at 1250 fathoms...	6°286				
1500 fathoms.					
100-103 (Miller)	36°9	6°5 6°7 6°6 5°8 5°8 5°8			
41	43°4				
42	43°6				
43	43°5				
100-103 (Miller)	37°8				
41	43°0				
42	43°0				
43	43°0				
Mean.....	6°200				
Correction for Miller ...	0°858				
Error at 1500 fathoms...	7°058				

Ocean-Observations by Staff-Commander E. K. Calver, 1869.

Pastorelli's Hydrographic-Office pattern.

N.B. The figures in antique type are rejected in forming the mean.

250 fathoms.			750 fathoms.		
Thermo- meter.	Minimum Index.	Difference from Miller.	Thermo- meter.	Minimum Index.	Difference from Miller.
100-103 (Miller)	48°0		100-103 (Miller)	41°2	
71	49°2	1°2	71	47°8	6°6
74	51°2	3°2	74	53°0	11°8
100-103 (Miller)	48°5		100-103 (Miller)	41°55	
39	49°5	1°0	39	46°2	4°65
40	58°0	9°6	40	50°4	8°95
75	49°5	1°0	75	45°6	4°05
100-103 (Miller)	48°35		Mean.....	4°350	
38	51°2	2°85	Correction for Miller ...	0°429	
Mean.....		1°067	Error at 750 fathoms ...	4°779	
Correction for Miller ...		0°143	1000 fathoms.		
Error for 250 fathoms...		1°210	100-103 (Miller)	38°5	
500 fathoms.			71	49°5	11°0
101-103 (Miller)	46°75		74	52°0	13°6
71	49°5	2°75	100-103 (Miller)	38°8	
74	49°5	2°75	39	45°5	6°7
100-103 (Miller)	46°9		40	...	...
39	49°5	2°6	75	43°8	5°0
40	58°0	11°1	Mean.....	5°850	
75	47°5	0°6	Correction for Miller ...	0°572	
100-103 (Miller)	47°5		Error at 1000 fathoms...	6°422	
38	52°2	4°7			
Mean.....		2°700			
Correction for Miller ...		0°286			
Error at 500 fathoms ...		2°986			

Ocean-Observations by Staff-Commander E. K. Calver, 1869.

Pastorelli's Hydrographic-Office pattern (*continued*).

N.B. The figures in antique type are rejected in forming the mean.

1250 fathoms.			1750 fathoms.		
Thermo- meter.	Minimum Index.	Difference from Miller.	Thermo- meter.	Minimum Index.	Difference from Miller.
100-103 (Miller)	37.9		100-103 (Miller)	36.7	
39	44.5	6.6	39	44.0	7.3
40	50.0	12.1	40	63.5	26.8
75	44.0	6.1			
100-103 (Miller)	37.9		Mean.....		7.300
38	45.8	7.9	Correction for Miller ...		1.001
100-103 (Miller)	37.65		Error at 1750 fathoms...		8.301
39	44.0	6.35	2090 fathoms.		
40	50.3	13.65	100-103 (Miller)	36.3	
Mean.....		6.350	39	44.0	7.7
Correction for Miller ...		0.715	40	44.0	7.7
Error at 1250 fathoms...		7.065	Mean.....		7.700
1500 fathoms.			Correction for Miller ...		1.144
100-103 (Miller)	37.0		Error at 2000 fathoms...		8.844
39	44.5	7.5			
40	44.6	7.6			
75	43.5	6.5			
100-103 (Miller)	36.9				
38	44.8	7.9			
100-103 (Miller)	37.2				
39	44.0	6.8			
40	64.6	27.4			
Mean.....		7.260			
Correction for Miller ...		0.858			
Error at 1500 fathoms...		8.118			

In the annexed diagram (Plate V.) the results obtained from the ocean-observations are laid down with those found by the use of the testing-apparatus; and it will be seen that there is considerable accordance between these determinations.

Progressive rate of Error of Hydrographic-Office pattern Thermometers as shown by the foregoing Tables of Ocean-Observations.

Casella.				Pastorelli.			
Depth.	Error.	First diff.	Second diff.	Depth.	Error.	First diff.	Second diff.
0 ...	0'000	0	0	0 ...	0'000	0	0
250 ...	1'329	1'329	+0'158	250 ...	1'210	1'210	+0'566
500 ...	2'816	1'487	-0'301	500 ...	2'986	1'776	+0'017
750 ...	4'002	1'186	+0'239	750 ...	4'779	1'793	-0'150
1000 ...	5'427	1'425	-0'566	1000 ...	6'422	1'643	-1'000
1250 ...	6'286	0'859	-0'087	1250 ...	7'065	0'643	+0'410
1500 ...	7'058	0'772	-0'529	1500 ...	8'118	1'053	-0'870
1750 ...	7'301	0'243	+0'167	1750 ...	8'301	0'183	+0'360
2000 ...	7'711	0'410		2000 ...	8'844	0'543	
+0'564 -1'483 Difference = -0'919				+1'353 -2'020 Difference = -0'667			
Equal to a decrease of effect at the rate of 0°·13 per 250 fathoms' pressure.				Equal to a decrease of effect at the rate of 0°·09 per 250 fathoms' pressure.			

**Comparison of the Errors of the Hydrographic-Office pattern
Thermometers as found by the hydraulic testing-apparatus
and by the Ocean-Observations.**

Casella.					Pastorelli.				
Pressure.	Error.		Per 250 fathoms.		Pressure.	Error.		Per 250 fathoms.	
	Press.	Ocean.	Press.	Ocean.		Press.	Ocean.	Press.	Ocean.
fms.	°	°	°	°	fms.	°	°	°	°
250 ...	1'307	1'329	1'307	1'329	250 ...	1'482	1'210	1'482	1'210
500 ...	2'789	2'816	1'394	1'408	500 ...	2'664	2'986	1'332	1'493
750 ...	3'821	4'002	1'274	1'334	750 ...	4'279	4'779	1'426	1'593
1000 ...	4'853	5'427	1'213	1'357	1000 ...	5'195	6'422	1'299	1'606
1250 ...	5'860	6'286	1'172	1'257	1250 ...	6'743	7'065	1'349	1'413
1500 ...	7'392	7'058	1'232	1'176	1500 ...	7'625	8'118	1'271	1'353
1750 ...	8'199	7'301	1'171	1'043	1750 ...	9'307	8'303	1'329	1'186
2000 ...	9'638	7'711	1'205	0'964	2000 ...	10'106	8'844	1'263	1'105
2250 ...	10'838	.....	1'204	.....	2250 ...	11'438	.....	1'271	.....
2500 ...	12'270	.....	1'227	.....	2500 ...	12'520	.....	1'252	.....
Means			1'240	1'233	Means			1'327	1'370
Error at 2500 fathoms by the means			12'4	12'3	Error at 2500 fathoms by the means			13'3	13'7

By this comparison, although the errors, as found by the two modes of observation, differ at individual depths or pressure, still the means of Casella's per 250 fathoms are almost the same, and those of Pastorelli's differ only three tenths of a degree in 2000 fathoms, the extent to which the comparison can be made.

It may be suggested that although the actual quantity of line to which the thermometers were attached in the ocean-observations was paid out, the certainty that the line was vertical throughout cannot be so fully depended on, especially at the greater depths; and if from the drift of the ship, by current or sea, the line beneath the surface assumed a curved line, the thermometers would not have attained the pressure of the depth indicated; at the same time, assuming (as is most natural) that the elasticity of the glass is not in exact proportion to the pressure, it would be advisable, in forming a scale for the correction of previous observations, to adopt a curve as nearly as possible between the results of the two modes of observation for each make of thermometer; and this curve is submitted in the accompanying diagram (Plate V.).

There can be little doubt that, without the aid of the Miller pattern, by an extended series of observations a scale could have been obtained to correct the Hydrographic-Office pattern to a very close approximation of the truth (in accordance with the

proposed first intention of the experiments); but the timely suggestion of Dr. Miller has quite set at rest any difference of opinion as to the instrument for future use.

To correct the deep-sea temperatures obtained by Sir James Ross and others with a class of instruments that cannot be obtained for comparison, observations made by the Miller patterns at a few of the same positions, uninfluenced by known ocean-currents, at as nearly as possible the same time of year as they were obtained in, and at precisely the same depths, would enable a scale to be made for correction which would be applicable to the whole series, and be sufficiently accurate to utilize them.

Aware of the mechanical difficulties attending the construction of these instruments, where men of great experience in their manufacture have failed, it would perhaps seem superfluous to suggest an improvement; still it may be hoped that, with the fault before him, some ingenious mechanic may devise a means to rectify it: the unsatisfactory nature of the indicators is alluded to. From experience gained, there is reason to believe that the exceedingly fine hairs used as frictional springs do not retain all the elasticity they possess when first secured to the bar, but deteriorate by soaking continually in spirits; and it stands to reason that it should be so, as the spirit must deprive the hair of its natural oil*.

With the above defect in view, the only remedy that suggests itself is, that a thermometer should never be sent down singly, but pairs; and although the occasional divergence of their indications may raise a doubt, a little practice will enable the observer to detect the faulty indicator; but when they agree, greater confidence of correctness will be the consequence.

Deep-sea Metallic Thermometers.

Previously to the experiments and the adoption of the Miller-pattern Six's thermometer (which leaves little or nothing to be desired), the invention of a metallic thermometer that could be depended on for deep-sea purposes was a great desideratum; and although the necessity for one has passed away, a record of those that have been invented for the purpose may fitly be appended to this paper—the more especially as, after the lapse of years, it is often difficult to obtain the original type, or even to ascertain the principle on which they were constructed.

* This has been partially remedied by Mr. Casella at the suggestion of the author, who, reasoning from the fact that the hair is a fine tube, proposed singeing or burning the end, and thus hermetically sealing it.

Johnson's Deep-sea Metallic Thermometer.

Invented by Mr. Henry Johnson, to be used simultaneously with his Deep-sea Pressure-gauge*, in the use of which temperature necessarily became an important element in calculating the depth, in determining how much of the variation in the volume of water indicated was due to variation of temperature.

Fig. 1.

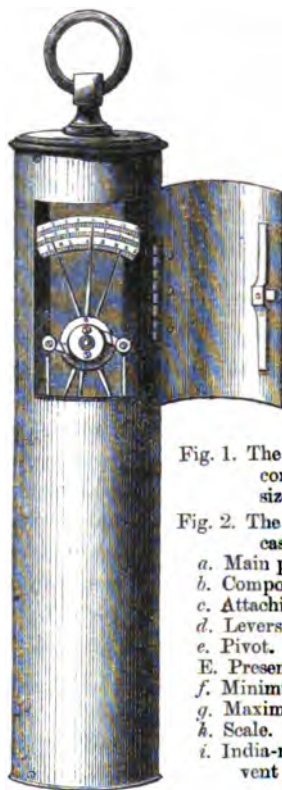


Fig. 1. The instrument in case complete: one-fourth size.

Fig. 2. The instrument out of case.



- a. Main piece or standard.
- b. Composite plates.
- c. Attaching plates.
- d. Levers.
- e. Pivot.
- E. Present-temp. indicator.
- f. Minimum indicator.
- g. Maximum indicator.
- h. Scale.
- i. India-rubber rings to prevent jar.

This instrument is composed of brass and steel, the well-known difference in the ratio of expansion and contraction by heat and cold of which is taken advantage of for ascertaining temperature. Compound bars of thin plates of these metals are riveted together,

* Mr. Johnson's pressure-gauge was tried in various forms; but (apart from temperature) owing, it is believed, to the difficulty of measuring the small difference, in quantity, of water compressed, and of getting that quantity free from air, it was pronounced impracticable for the purpose intended.

which slightly curve in one direction when heat has expanded the brass more than the steel, and attain a slight curve in the contrary direction when the cold has contracted the brass more than the steel. The indicator records the motions under change of temperature.

In the composition of the bars the proportion of brass (the more dilatable metal used) is double that of steel, or two thirds of brass to one of steel.

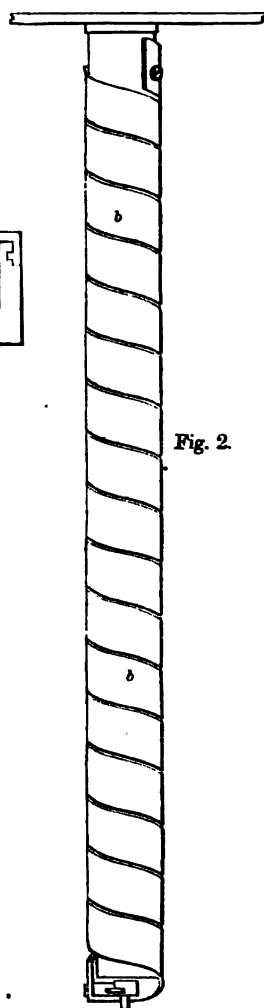
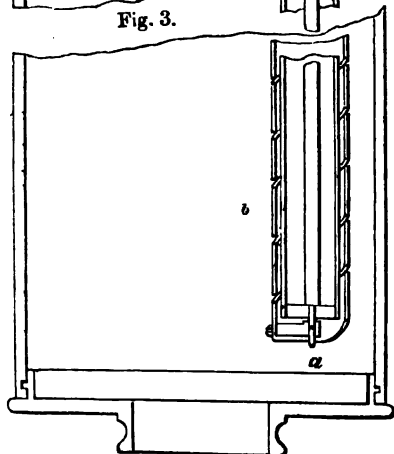
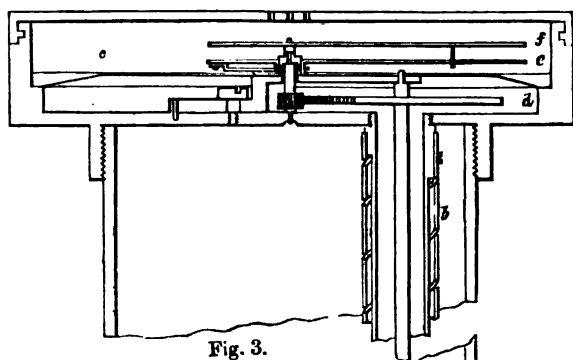
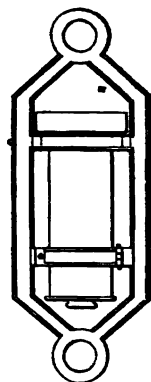
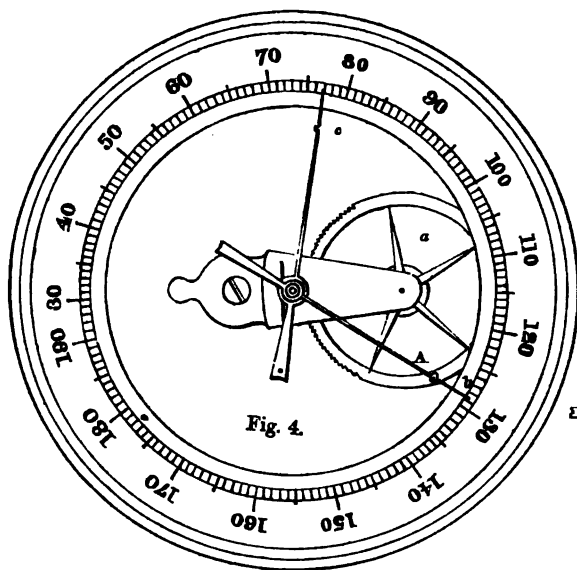
The maximum and minimum indicators are pieces of split brass, which, by its nip, causes enough friction to prevent their being moved by shaking or knocking, at the same time not enough to prevent the free action of the present-temperature indicator.

The pivot on which the indicator works is of gold, and the surrounding parts washed with the same metal, to prevent oxidation.

This instrument has often been condemned from its want of agreement with the mercurial thermometers sent down with it; but now that there is proof of the effect on the latter by pressure, that disagreement is accounted for, and in most cases in which its notification has been rejected it would now be found correct.

Saxton's Metallic Thermometer.

In the report of the Superintendent of the United-States Coast Survey of 1860, is contained an account of the deep-sea thermometric instruments used in the survey of the Gulf-Stream; and the instrument mainly depended on seems to have been an adaptation of the Breguet principle of the coil-form of two metals, by Joseph Saxton, Esq., and consists of two stout ribands of silver and platinum, carefully united with silver-solder and coiled spirally, the more expansive metal being within; a coil of gold, to which each metal is soldered, serves to prevent the tendency of the silver and platinum to separate: the lower part of the coil is affixed to a brass stem which passes up through the centre of the coil, while the upper end is fastened to the base of a short cylinder which keeps that end of the coil from turning, and consequently conveys the whole motion of the coil, caused by the unequal expansion or contraction of the two metals, to the lower end of the spindle, the turning of which is communicated to multiplying-wheels placed within the short cylinder, which serve to magnify the motion of the coil and move a hand, which in turn carries with it an index to record the extreme maximum or minimum.



This instrument was found to have a considerable error under pressure, and it is supposed that the solder by which the two metals are cemented together was so affected by the compression as to cause the error; but it may be due to the construction of the instrument itself, as there can be no certainty that the expansion and contraction of the two metals *are* communicated at the end of the spiral ribands, and may not be developed at the sides (the ribands not being close to the bar around which it is coiled).

If the communication of the contraction and expansion could be depended on at the end of the ribands, it would seem that a simple but long coil of wire could be so encased that the direct action could be communicated to an indicator for the purpose of registering the temperature indicated by its elongation or expansion and contraction.

DESCRIPTION OF WOODCUT.

Fig. 1. The instrument complete: one-sixth size.

Fig. 2. The stem and coil: full size.

a. Stem. b. Silver and platinum coil.

Fig. 3. Section: full size.

a. The stem. b. The coil. c. Short cylinder.
d. Magnifying wheel. e. Present-temperature indicator.
f. Registering indicator.

Fig. 4. Short cylinder: full size.

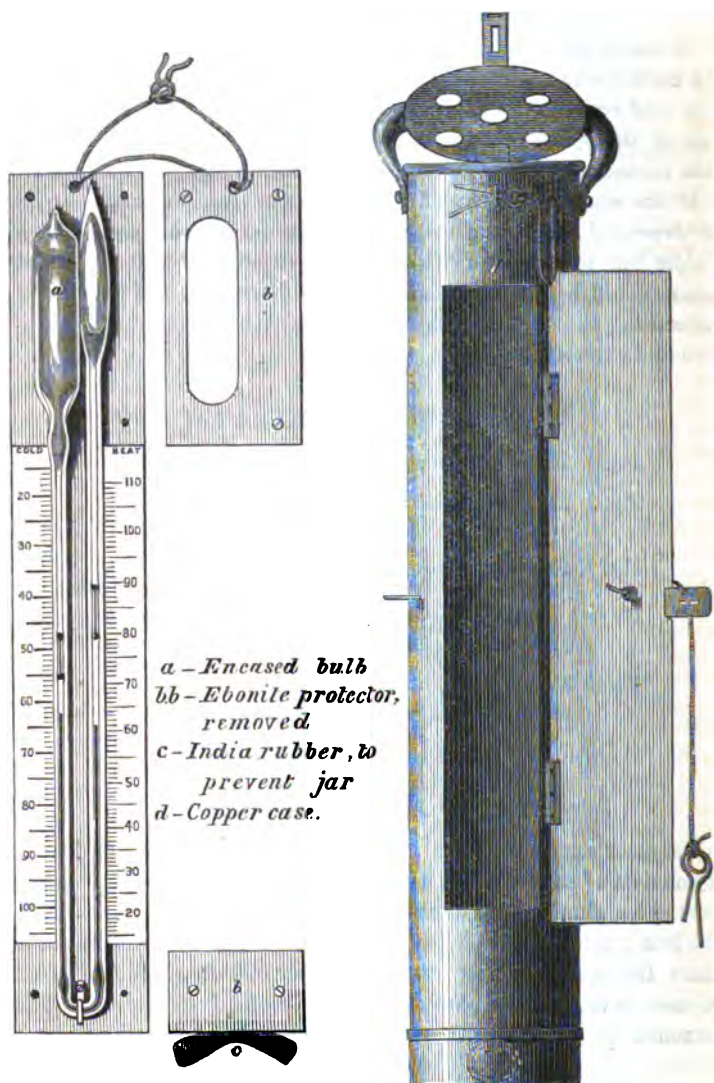
a. Magnifying wheel. b. Present-temperature indicator.
c. Registering indicator.

Header's Metallic Thermometer

is the most simple and has the most direct action of the three: it consists of an iron tube, within which, and secured to the lower part by a socket, is a bar of another metal of unequal expansion with the iron; this unequal expansion is communicated by means of a short fulcrum to a long lever, the upper end of which is toothed to meet a small wheel correspondingly toothed: to this wheel is attached the hand, the index being moved by the hand and kept in its place by means of friction.

An instrument of this description has not been completed as a thermometer; but the author has seen the action of an experimental instrument, and it seemed to answer well.

It is the invention of Dr. Jonathan Header, of Plymouth.

Six's Self-registering Deep-sea Thermometer (Miller pattern).

CORRESPONDENCE, &c.

A. M. le Président de la Société Météorologique.

Moncalieri, 30 Mars, 1871.

MONSIEUR LE PRÉSIDENT,—Dans l'appareil de déclinaison magnétique de cet observatoire on a remarqué le 12 février une perturbation assez forte. Son commencement eut lieu le matin et continua jusqu'à nuit avancée. Elle atteignit son maximum entre les 9 heures et les 9½ du soir : dans ce dernier temps le déclino-mètre était très-agité, et s'était égaré de 27^m vers l'Est de la position qu'il avait à midi. C'est la plus grande perturbation qu'on ait remarqué après la perturbation extraordinaire magnétique qui a été causée par les aurores boréales arrivées les jours 24 et 25 Octobre passé.

Comme les autres éléments météorologiques ne donnaient aucune indication de l'approchement d'une tempête, je pensais que ces mouvements irréguliers étaient causés par une de ces tempêtes que M. Humboldt appelle magnétiques, c'est-à-dire par une aurore polaire. Mais quoique nous ayons été sur l'observatoire comme de coutume pour nos observations sur les étoiles tombantes, jusqu'à onze heures du soir, néanmoins nous ne pûmes rien voir, surtout parceque le brouillard, qui dans ce temps était fort épais, couvrait la partie septentrionale du ciel jusqu'au zénith.

Or le lendemain me sont arrivées deux relations diligentes d'un beau phénomène auroral qui a été observé à Volpeglino près de Tortona (Piémont) par M. l'abbé Maggi, et à Florence par M. le Père Bertelli, professeur de physique dans le Collège à la Querce.

Les deux relations s'accordent parfaitement, pour ce qui touche les circonstances particulières de l'apparition. La lumière auro-rale commença se montrer vers le nord à 9½ précisément lorsqu'ici on avait la plus grande perturbation magnétique. Elle parvint à son maximum à dix heures et demie ; dans ce temps-là, comme l'abbé Maggi dit, elle contenait 88° en largeur, de l'étoile ϵ d'Hercule à la λ d'Andromeda, et s'élevait jusqu'à la hauteur de 40°, sa forme ressemblait à un segment de cercle. La lumière du météore apparut à Florence d'une couleur blanche rosée, à Volpeglino d'une couleur jaune pâle. A onze heures tout était terminé.

Cette fois même on a remarqué une augmentation dans le nombre et dans la dimension des taches solaires. M. l'abbé Maggi m'écrit que le matin du 12 courant à l'aide de son télescope on a compté 80 réunies en 9 groupes au milieu de beaucoup de facules. Je n'ai pu reprendre qu'hier mes observations accoutumées sur le soleil, parcequ'il n'y a que peu de jours que mon réfractoire m'est arrivé de l'expédition de l'éclipse totale du 22 Décembre. Hier nous comptâmes 44 trous entre les grands et les petits, sur la surface solaire : ce matin comme les conditions de l'atmosphère étaient plus favorables, nous en avons pu compter jusqu'à 102.

Par une lettre que je viens de recevoir du Rév. Père Secchi, je puis connaître que l'aurore polaire qui a été vue à Volpeglino et à Florence, a été observée même dans les environs de Rome, mais avec un peu de retard, et avec une intensité plus grande que dans les lieux dont nous venons de parler. En effet à Frascati le météore apparut vers les 8 heures du matin du jour 13 et il fut un peu moins brillant que celui du mois d'Octobre passé. Ce qui prouve que l'aurore qu'on a vu au nord de la péninsule dans les premières heures du soir du 12, s'est reproduite plus brillante dans le matin du 13, au moins près de Rome.

M. F. Marchetti assistant au Collège Romain ajoute que dans le soir du 12 le ciel lui parut teint d'une couleur rougeâtre, et qu'à Rome la perturbation magnétique a été même dans ce jour-là plus forte, surtout le soir.

L'aurore a été observée même à Modena par le Professeur Borzoni, Directeur de cette observatoire.

Certainement ce phénomène auroral n'a pas été aussi éclatant que celui du 24 et 25 Octobre passé, mais cependant il est de la même nature. Le grand nombre des faits que nous avons à cet égard nous font voir clairement que les aurores qu'on appelle polaires, quoique plus fréquents dans le Nord que dans les autres régions, cependant elles ne sont pas seulement à ce lieu. Il arrive aux aurores polaires ce qu'il arrive aux tempêtes dont il y en a qui s'étendent sur des extensions considérables, et il y en a au contraire qui sont tout-à-fait locales.

La fréquence de ces météores dans certaines contrées qui se trouvent à des latitudes peu élevées nous donnent de nouvelles idées sur leur théorie: mais pour mettre en effet ces vues théoriques il nous faudrait beaucoup d'observations faites avec des personnes attentives et intelligentes, dont le nombre est trop petit.

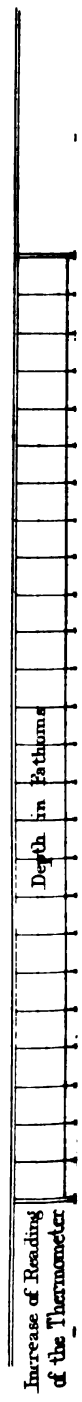
Les études assidues qu'on a fait sur tout ce qui peut regarder la nature et l'origine de ce phénomène, quoiqu'elles en aient établi la physionomie générale, elles sont cependant pleines d'incertitude graves, ce qui nous est prouvé par le grand nombre de phases qui a subi la théorie des aurores polaires depuis Gassendi et Muscembroek jusqu'à De La Rive et Silbermann, et qu'ira subir ensuite, après surtout les belles observations spectroscopiques exécutées récemment sur la lumière aurorale.

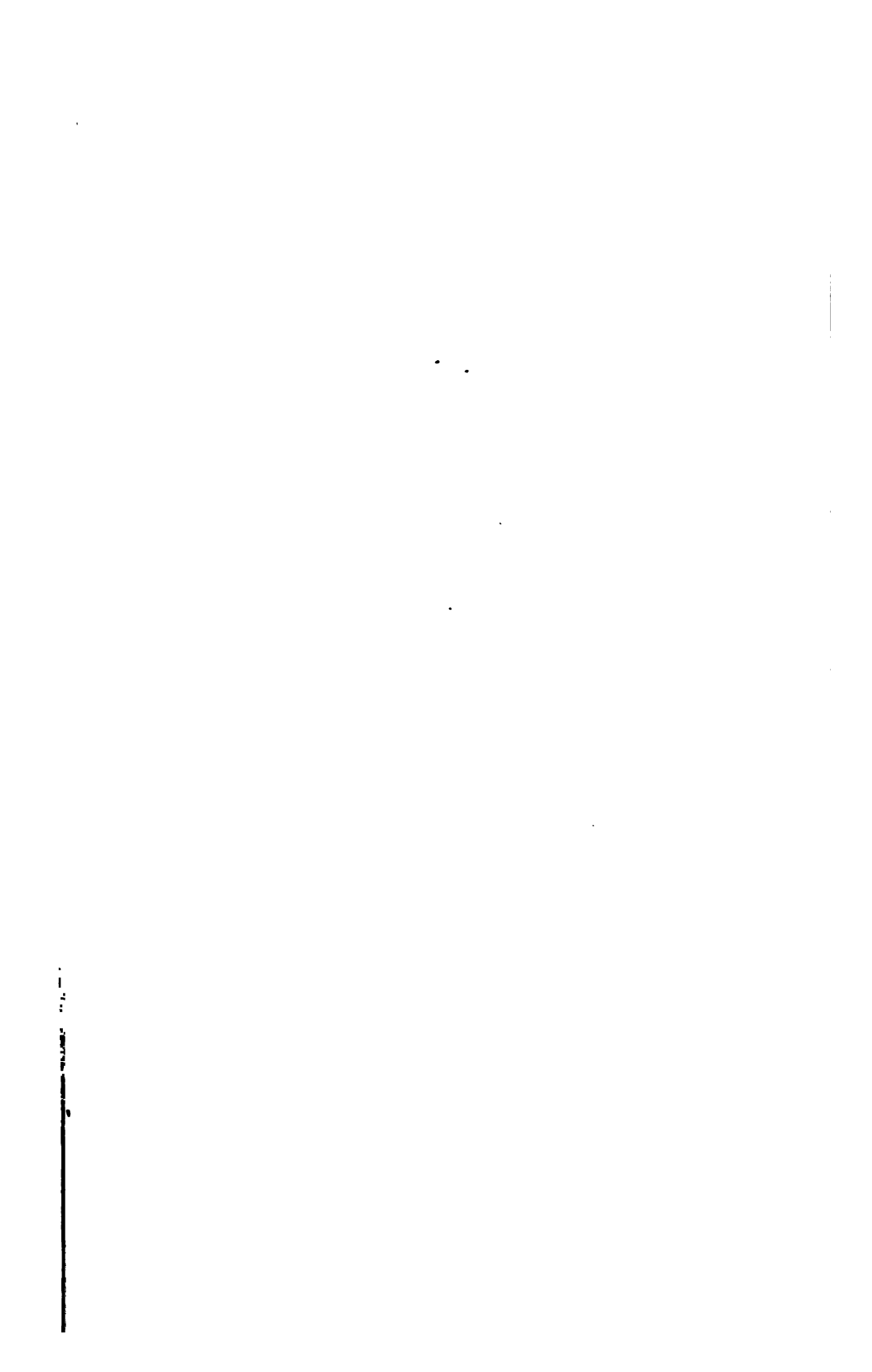
Un autre phénomène auroral a été observé en Piémont pendant la nuit du 17 au 18 Mars, depuis 14^h 25^m jusqu'à 15^h 40^m (t. m. local). Une lumière aurorale très-vive a été vue d'abord dans le Cocher, et puis dans Persée: deux faisceaux très-brillants s'élevaient au-dessus de cette lumière.

Enfin, une troisième apparition d'aurore polaire a été vue à Venise à 16^h du matin du 24 Mars.

P. F. DENZA.

OF THE TESTING APPARATUS, THE ERROR OF THE MILLER PATTERN AND THE ERRORS OF THE HYDRO-
N° 3. -GRAPHIC OFFICE PATTERN AS FOUND BY TESTING APPARATUS AND OCEAN OBSERVATIONS.





Vol. V.]

[No. 56.]

PROCEEDINGS
OF
THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

1871, JUNE 21.

CONTENTS.

Annual General Meeting:—

Report, 345. Directors: Charles F. Brinkley, 354; The Right Hon.
Sir V. Palliser, Bart., 355; The Hon. Joseph Stansfeld, Bart.,
M.A., F.R.S., 356. Papers Read, 357; Officers and Council,
358; Balance-Sheet, 359 and 361; Resolutions, 362; Meetings,
363.

Table, Contents, Index, &c.

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1871, September.

ADVERTISEMENT.

ADVERTISEMENTs are requested to be sent to the Publishers, Messrs. TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

Scale of Charges.

	£	s.	d.		£	s.	d.
Five lines and under	0	4	0	Page	1	10	0
Above five lines, per line..	0	0	6	Bills, half-sheet and less..	1	10	0
Half a page	0	17	6	„ whole sheet	2	0	0

ORDINARY MEETINGS

OF

THE METEOROLOGICAL SOCIETY,

SESSION 1871-72,

25 GREAT GEORGE STREET, WESTMINSTER, S.W., AT 7 P.M.

1871. November	15		1872. March	20
1872. January	17		„ April	17
„ February	21		„ June (ANNUAL)	19

In cloth boards.

PROCEEDINGS OF THE (BRITISH) METEOROLOGICAL SOCIETY.

Vol. I. £1 1s. Vol. II. £1 5s. Vol. III. £1 5s. Vol. IV. £1 5s.

Cases for binding (price 1s. 3d. each) may also be had of the Publishers.

Price 2s.

GLAISHER ON THE METEOROLOGICAL AND PHYSICAL EFFECTS OF THE SOLAR ECLIPSE OF MARCH 15, 1858.

Fifth Edition, price 2s. 6d.

GLAISHER'S HYGROMETRICAL TABLES.

Hygrometrical Tables to be used with, and Description of, the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Fourth Edition, price 1s. 6d.

GLAISHER'S DIURNAL RANGE TABLES,

Newly arranged, containing Corrections for Temperature, adapted to different Hours of Observation, for different Ranges of Daily Temperature, with similar Corrections for the Barometer, &c.

Third Edition, price 1s.

BELVILLE'S MANUAL OF THE MERCURIAL AND ANEROID BAROMETERS.

Price 1s.

BELVILLE'S MANUAL OF THE THERMOMETER.

“Those who desire correct information on the best means of observing Meteorological phenomena, will find what they require in Mr. BELVILLE'S Books.”—*Athenæum*.

TAYLOR and FRANCIS, Printers and Publishers to the University of London, Royal Society, &c., Red Lion Court, Fleet Street, E.C.

PROCEEDINGS

OF

THE METEOROLOGICAL SOCIETY.

EDITED BY
JAMES GLAISHER, F.R.S., SECRETARY.

VOL. V.]

1871, JUNE 21.

[No. 56.]

ANNUAL GENERAL MEETING.

1871, JUNE 21.

REPORT.

CHARLES V. WALKER, F.R.S., F.R.A.S., PRESIDENT, in
the Chair.

DURING the past year the general condition of the Society has been one of prosperity, and the Council have pleasure in speaking of the steadiness of the work performed both by institutions and individual observers.

Briefly advertng to the subjects which have been brought under the notice of the Society since the last Anniversary, the different papers are the first subject which claim our attention.

At the first Meeting of the Society in the Session 1870-71, a paper was read by Mr. G. Dines "On Evaporation and Dew," a subject which has occupied the attention of several gentlemen during the year. The author treating of Evaporation, after having remarked upon the great differences which exist between the results of any two observers, says: "This paper does not pretend to give the true quantity of error, but only to point out the causes of such differences, the faulty construction of many of the present evaporation-gauges, and also to lay down the conditions which

must be observed before the true amount can be determined." He then proceeds to describe the method adopted in his experiments, the latter being made at different temperatures, sometimes with water of natural temperature, at others with heated water, and again with water artificially cooled; and he is led to the conclusion that "the line of demarcation where condensation ends and evaporation begins, must be at or very near to the dew-point temperature;" and for the purposes of the paper, he assumes the two following propositions to be correct:—

"1. That no evaporation takes place from water unless the temperature of the water is greater than that of the dew-point.

"2. That the amount of evaporation from water is proportional to the difference of the pressures of vapour at the temperature of water and at the temperature of the dew-point."

He then, after describing some of the evaporation-gauges used, concludes by giving the results of his experiments, amongst others being the fact "that the smaller the gauge, the greater the proportionate increase of evaporation," and gives his opinion as to the various causes upon which evaporation depends. The next paper upon this subject was that by Mr. J. B. Mann, "On Evaporation, Rainfall, &c." read at the March Meeting. The author, from his experiments, found the following formula as accurate through all the variations of temperature, &c. "as he could anticipate:"—

Depth of evaporation per hour in inches

$$= 1.5 \sqrt{T + \left\{ 1 - \left(\frac{e}{e_1} \right) \right\}} \times D,$$

where T = the absolute temperature of surface-water, evaporating in degrees Fahr. (that is, $461 +$ the ordinary scale),

e = elastic force of the vapour in the air in inches,

e_1 = elastic force of vapour due to the temperature of the water evaporating, Fahr.'s scale;

and, agreeing with Mr. Dines, he found that "the height of the surrounding rim of the evaporating-vessel above the surface of the water, as compared with its diameter, had a very material effect upon the amount of evaporation." Mr. Dines also read a second communication on the dew-point at the Meeting in March.

The brilliant displays of Auroræ on October 24 and 25, 1870, have furnished us with two papers. One being the reports from the different observers of the Royal Observatory, Greenwich, and the other, a short note by Dr. Mann, stating that displays were seen as far south as $28^{\circ} 30' S.$ At the January Meeting, Prof. A. S. Herschel contributed a paper on the Heights and Velocities of August Meteors, in which he gave a detailed account of the several steps by which he arrived at the required values. This was followed by a short paper on the extraordinary period of Cold Weather which was experienced in England during the latter end of December 1870

and beginning of January 1871, in which the author (our Secretary) states "that in the fifty-seven years ending 1870 there have been but two periods of longer duration of cold weather," although the degree of cold was not nearly so severe as has been experienced on many similar although shorter periods; and from his researches, back to the year 1771, he says "it would appear that the winters at the latter end of the last century were much colder than any during the last thirty years."

"On the Influence of the Moon upon the amount of Rainfall" is the title of a paper by Mr. J. C. Bloxam, and is a continuation of a similar article by the same author, which was read at the February Meeting of 1870. Dr. R. J. Mann has contributed two papers during the Session, both of which were presented at the February Meeting; the first is on "a New Classification of Clouds," and in his opening remarks the author states his object as being "simply to draw the attention of English meteorologists to the chief practical points" of the new classification proposed by Professor Poey, which Dr. Mann presents as a synopsis; the second of the papers by this gentlemen has been noticed in the summary of the communications on *Auroræ*.

At the March Meeting Mr. J. J. Hall exhibited and described a new Electro-Magnetic Anemometer, and Mr. Symons exhibited and explained a new and extensive apparatus for the determination of the amount of evaporation of water from a large surface; since that time it has received such very extensive alterations as to become virtually a new instrument, and as such may probably again come under the notice of the Society. The last, and probably the most important, paper of the Session was read at the April Meeting, entitled "on Deep-Sea Thermometers," by Capt. J. E. Davis, R.N.

SCOTTISH METEOROLOGICAL SOCIETY.—At the Meetings of this Society from January 1870, several valuable and important papers have been read, foremost among the authors being the Secretary, Mr. Alexander Buchan, M.A., F.R.S.E., with the following papers:—"On the Rainfall of Scotland," in two articles; "Notice of Two Sudden Changes of Temperature as recorded by the Marquis of Tweeddale's Self-registering Meteorological Apparatus;" and, in conjunction with Dr. Keith Johnson, "The temperature of the Sea between Scotland, Farø, and Iceland." The first, as its title implies, is a digest of the observations upon rainfall taken all over Scotland, and is undertaken for determining the average falls at each station. The second paper is a notice of two sudden changes of temperature which occurred, one on the 22nd of March, 1870, and the other on the 28th of August in the preceding year. "The Temperature of the Sea &c." is the continuation of similar papers which were presented to the Society in

January 1862 and July 1865. Since the date of the last paper, the area of observation of the temperature of this part of the Atlantic has been largely extended, and in the summer of 1866 the requisite instruments were supplied by the Society to three new observers; in the following summer, Professor Mohn of the Norwegian Meteorological Institute had nine observers placed under his direction: this paper gives an account of the observations made over this extended area.

"Chemical Climatology" is the title of a paper by Dr. Angus Smith, F.R.S.; and Surgeon-Major W. T. Black gives a description of Two Rain-gauges, one of which is to be used on board ship and the other on land. The principle upon which these instruments are constructed obviates the necessity of emptying them every time it is wished to ascertain the amount of rainfall, the registration of the quantities being effected by glass tubes on opposite sides. D. Milne Holme contributed a paper to the May Meeting of 1870, entitled "Suggestions for Increasing the Supply of Spring water at Malta, and Improving the Climate of the Island." The experiment suggested by the author is to form extensive plantations of trees on the island: it may be remembered that Mr. Meldrum, in his paper on the rainfall of Mauritius, speaks of the destruction of the forests as being the probable cause of the great decrease in the rainfall in that colony, and, in conclusion, says, "If that is really the cause, it would seem that the proper remedy is to restore, as far as practicable, certain portions of the forests of which this once salubrious and beautiful island has been deprived;" and a Commission was appointed to report upon it. Mr. Holme in the course of his paper quotes several well-known names in support of his views, as Humboldt, Boussingault, Strzelecki, Blanqui, &c. "On Meteorological Gradients" and "Proposed Method of ascertaining the Temperature of Falling Rain" are the titles of two papers presented at the September Meeting by Thomas Stevenson, C.E., F.R.S.E.; and at the same Meeting William Macdougall, C.E., gave a description of a new form of self-registering maximum and minimum thermometer. The instrument is on the same principle as Six's, to a certain extent, but it is hung horizontally instead of vertically; at an increase of temperature the maximum index is pushed forward by mercury to the point of greatest elevation, and at a decrease the minimum index is pushed backwards to the point of greatest depression of temperature.

"The Temperature of the British Islands," by Alexander Buchan, M.A., is the discussion of the observations made both in England and Scotland. Mr. T. Stevenson, C.E., in a paper on "Instruments proposed for ascertaining the Mean Temperature," draws attention to the fact that "the information afforded by isolated observations of the thermometer is insufficient for determining accurately the mean temperature of a district," and pro-

poses to obviate this difficulty by means of a *solar dynamometer*, an illustration of which is given in the paper.

THE NORWICH METEOROLOGICAL SOCIETY, although only in the second year of its existence, is progressing very satisfactorily; this year it numbers 66 Members, being an increase of 17. The anemometer works very well, daily records of the direction and force of the wind are kept, and much interest is taken in the recording powers of the instrument by the local public.

At the first Annual Meeting held by the Members on the 1st of July, 1870, Mr. S. Gurney Buxton was elected President, and the Rev. C. J. Steward, F.M.S., and Mr. John Gurney, Vice-Presidents. At the same Meeting a paper was read by the excellent Assistant-Secretary, Mr. J. Quinton, jun., on the Rainfall of Norwich for the last thirty years, which showed that the greatest amount of rain had been registered in the following years:—

1841=31·17 ins.,	1852=30·74 ins.,
1848=31·02 ins.,	1860=30·59 ins.;

the least was in 1864, when only 14·52 ins. were registered; most rain was found to have fallen in the months of July and October, the least in February and March.

The average annual rainfall was 23·58 ins.

In November 1870 a most interesting lecture was delivered on rain by Mr. Glaisher, F.R.S., on behalf of the debt incurred by the Society in the erection of the anemometer. Daily records of the barometer and of the temperature are taken at 9 A.M. and 3 P.M.; copies are forwarded weekly to Mr. Glaisher, and a copy monthly of all the meteorological observations, for insertion in the Registrar-General's Quarterly Report.

The Society has this year issued its first Report on the Meteorology of Norwich, consisting of the highest, lowest, and mean monthly readings of the barometer and thermometer, the dew-point, and other hygrometrical results obtained from Mr. Glaisher's Tables, with the rainfall, direction and velocity of the wind, and remarks on the weather.

The Society has unhappily sustained a great loss during the past year by the death of Mr. James Newbegin, one of its most active Members, who took great interest in the erection of the anemometer and formation of the Society.

The Rev. J. M. Duport, M.A., one of the Members of the Society, publishes monthly, in the 'Norfolk Chronicle,' the daily rainfall from twenty-four stations in Norfolk.

BOURNEMOUTH METEOROLOGICAL SOCIETY.—This Society has

been established three years, and has printed for each year a very interesting Report, including essays by some of its Members on special questions. The Society has five stations, at which meteorological observations are carefully taken, and monthly Reports are supplied regularly to the 'Bournemouth Visitors' Gazette' and the 'Christchurch Times:' among the names of its Members we recognize four of our own Fellows, and we wish this little Society every success in its praiseworthy undertaking.

WEST CORNWALL: ROYAL CORNWALL POLYTECHNIC SOCIETY.

—This Institution has issued a small pamphlet on the meteorology of West Cornwall during the year 1870, as deduced from observations taken at five stations, viz. Bodmin, Truro, Falmouth, Helston, and Penzance, from which we extract the following particulars:—

"The average height of the barometer was 30.012 inches, the range between the *highest* and *lowest mean*, amounting to 0.040 inch, being the difference between the maximum at Helston and the minimum at Penzance. During the year the barometer attained its greatest height no less than 230 times *about the middle of the night*, and on 66 occasions it reached its maximum *about the middle of the day*: whilst it was quite exceptional for it to be highest during the morning or afternoon. The minimum pressure is more evenly distributed; but midnight is still the hour at which the pressure is at its minimum more frequently than at any other period.

"The mean temperature of the district was 51°.3; the highest temperature was 84°, registered at Truro on July 24th, and at Helston on three occasions, one each in the months of June, July, and August; the lowest temperature was 14°, also at Truro, on December 9th and 30th.

"The average velocity of the wind as recorded at Falmouth was 17.1 miles per hour, the monthly velocity being greatest in October, and least in July; whilst the greatest distance travelled in one hour was 66 miles on January 8, the direction of the wind being S.W., and the mean pressure for the hour 21.8 lbs. per square foot."

ROYAL OBSERVATORY, GREENWICH.—The meteorological instruments,—namely, barometers, dry and wet thermometers (all adapted both to eye-observation and photographic self-registration), anemometers for pressure and speed, and pluviometers (all for mechanical self-registration), other pluviometers at different heights, and thermometers in the ground and in the Thames—are all in good order. Only one change has been made. The thermometers formerly attached to the 'Dreadnought' Hospital Ship

were removed on April 13, 1870; since 1871, January 11, they have been attached to the 'Scorpion,' Thames Police Ship, moored off Blackwall; and the observations have been regularly made by the Resident-Inspector of Police on board that ship, by permission of Colonel Henderson, R.E., C.B., Commissioner of Metropolitan Police.

We are still without self-registering electrical apparatus; but the old apparatus has been brought into a more satisfactory state, and is used for eye-observations.

Arrangements were made for observations of meteors on all the nights specially mentioned by the Meteor-Committee of the British Association; and particularly on the nights of expected meteor-showers in August, November, and April last. That of August was well observed; that of November only on November 14 and 15; the other nights were cloudy.

For the meteorological observations,—remarking that, in virtue of the constructions of the instruments, the anemometers and the photographic registers of the thermometers require no new ordinate scales,—it is sufficient to state that all eye-observations are cleared of known errors, that dew-point and degree of moisture are computed to the present time, and that time-scales and base-lines are drawn upon the photographic sheets to the end of 1870.

The number of rotations of the vane of Osler's anemometer in 1870, moving in the direction N., E., S., and W., were 9 fewer than in the opposite direction.

The daily meteorological observations are printed, as has been done for many years past, in a monthly division, giving results rather of civil than of scientific utility; still, however, embodying several scientific results, which could be established without requiring great labour and great space. The observations of meteors of the April, August, and November periods, as well as of meteors generally, are given in sufficient detail. The highest and lowest barometric readings, the depth of rain registered at different heights above the ground, and the daily readings of the thermometers at different depths of the earth are printed.

Circumstances will prevent in the present year any great progress being made in the systematic reduction of photographic meteorological records from 1848 to 1868. The ordinates of the dry and wet thermometers for every hour, as well as the corresponding eye-observations, had been entered (at the last Report) into the proper printed forms; the portions relating to waves of high and low temperature and to waves of high and low atmospheric pressure have been marked off through the whole period, and the means have been taken for the temperature-waves, as well as for each month, through about ten years.

In the ordinary conduct of an observatory of this class there is little difficulty (although much labour) in maintaining general regularity. As illustrating this, it may be remarked that the

current reductions of observations are in as healthy a state as they have ever been in. These regular reductions give, in general, great facility for the most advanced inferences, the magnetic reductions distinctly, though tacitly, exhibiting some of those results (for instance, annual inequalities) which in various observatories have been the subject of special memoirs.

But from time to time it becomes desirable to unite some of those annual or nearly annual results in groups, so as to exhibit the results justly derivable from masses of observations extending over long periods of years. These operations require new organizations; and, more, they require additional grants of money. The following are perhaps the more important subjects for consideration:—

1. The vigorous prosecution of the meteorological reductions (exhibiting the results deducible from the photographic registers) already begun.

2. The combination of the results of magnetic observations on undisturbed days, from the year 1864.

3. The discussion of magnetic storms, from the year 1858.

4. Perhaps, also, the discussion of observations in groups depending on lunar declination, or other phases.

The following magnetical results for 1870 may be interesting:—

Mean westerly declination	19° 54' nearly.
Mean horizontal force	{ 8.865 (in English units). 1.782 (in metrical units).
Mean dip	{ 67° 51' " (by 9-inch needles). 67 52 25 (by 6-inch needles). 67 53 41 (by 3-inch needles).

The observations of dip at different hours appear to show a diminution from 9^h A.M. to 3^h P.M., but the number of observations is at present too small to enable me to state the quantity as a result of observations with the dip-instrument. The dips, of which the results are given, were usually taken at about 2^h P.M., sometimes earlier, sometimes later.

PARIS OBSERVATORY.—In the midst of the unhappy events through which France has passed, the kind cooperation of the meteorological correspondents and the not less active cooperation of the telegraphic services of France and the friendly nations have enabled the publication of the 'International Meteorological Bulletin' to be continued throughout the period of the investment of the city by the Prussian army. For effecting this continuity of publication the Meteorological Director, with M. E. Fron, left Paris at the commencement of the investment, and followed the Governmental delegation into the provinces. Afterwards, during

the formidable insurrection within the walls of Paris, the publication of the 'Bulletin' was unavoidably stopped for a time; but regular meteorological observations have been continued at the Observatory with little or no interruption, both during the investment by the foreign army and the temporary rule of the insurgents.

Since the beginning of the year the regular meteorological observations have ceased to be the charge of the astronomical assistants, and are now placed under the care of the assistant charged with physical researches. It will therefore be no more necessary to limit these observations to the meteorological instruments placed in the immediate vicinity of the astronomical instruments, and advantage has been taken by this change to fill up the regrettable gaps in the meteorological service. The following is an outline of the observations which will now be carried into effect, with information upon the nature and position of the instruments. For the purpose of rendering these explanations more easy for reference, the columns containing the observations are numbered in the new Tables in the Bulletins.

1. The 1st column contains the hour of observation, and requires no further remark, except that the first reading of the instruments (which is specially taken for the service of the 'Bulletin') is made at 7^h A.M. during the six summer months, and at 8^h A.M. during the six winter months.

2. The 2nd column gives the height of the barometer reduced to 0° C., but without correction for height above sea-level. That correction, which is +6 millims., is constant, and is used only for the meteorological charts. The barometer, which is by Fortin, was mounted by Arago in the rotunda adjoining the hall containing the meridional instruments. It can be read to hundredths of a millimètre, but it is thought unnecessary to read beyond tenths.

3 & 4. By the name of ancient thermometers are designated the instruments mounted by Arago at the north of the rotunda, wherein the barometer is mounted, and which continue the series of observations under conditions similar to those under which the preceding series had been made. The 3rd column contains the temperatures recorded by the thermometer constructed by Fortin upon the model of the thermometer by Mussy. This latter instrument was constructed by order of the Academy at the end of the last century, and was mounted at the Observatory by Cassini IV. in July 1785. The 4th column contains the maximum and minimum temperatures given by Six's self-registering thermometer constructed by Fastré. Six's and Fortin's thermometers are placed side by side under a little movable house carried by an iron gibbet, and by means of a mechanical arrangement they can be brought to the window of the Observatory for observation, and then replaced again in their proper position. These thermometers, particularly that of Six, which is alcohol, are of large size, and consequently somewhat sluggish; they are

placed at a height of seven mètres above the court at the north of the Observatory, and at a distance of only one mètre from the wall of the building. It is evident that the readings of these instruments do not represent at all the temperatures which would be obtained under other and more favourable conditions; but in this case the conditions have been always the same during the past eighty years, and the observations by these instruments are therefore valuable for comparison with years during that period of time.

Whilst preserving with care these ancient instruments, others have been established under different conditions.

Arago, at the meeting of the "Bureau des Longitudes," 17th February, 1830, proposed to attach a thermometer to a machine rotating with great speed, and producing an artificial wind. He hoped thus to obtain the temperature of the air irrespective of the effects of radiant heat from bodies with which the thermometer is surrounded. A machine of this kind is mounted near the fixed thermometers, but has been for a long time out of use, owing to the "sling" thermometer fulfilling the same purpose. The latter is a thermometer of small dimensions provided with a cord of silk, by means of which a rapid rotatory movement around the hand is obtained before making the reading. This thermometer is observed upon one of the grass-plots of the terrace-garden of the Observatory, in the shade thrown by the cover of the new thermometers, and its indications are printed in column 5.

The new thermometers consist:—1st, of a mercurial thermometer graduated upon its stem to 5ths of degrees; 2nd, of another thermometer (also mercurial), in which a portion of the column is separated from the rest by a small bubble of air serving for index, and giving the maximum temperature (it is the thermometer known in France under the name of Walferdin); 3rd, of an uncoloured spirit-thermometer, with floating index, giving the minimum temperature. These three thermometers are suspended nearly horizontally by double strings stretched vertically in a brass frame, which is suspended, at the height of two mètres above the ground, in the middle of a grass-plot in the terrace-garden of the Observatory, under a double shelter of planks supported by four wooden posts, and covered with canvas.

ROYAL OBSERVATORY, EDINBURGH. Prof. C. P. Smyth.—The reduction of the daily observations taken at fifty-five stations of the Meteorological Society of Scotland has been carried on here as usual; and the results have been printed in the Monthly and Quarterly Reports of the Registrar-General of Births, Deaths, &c. in Scotland.

Allusion was made in last year's Report to a special reduction, on a uniform system, of thirty-three years of observations of the

very remarkable set of deep rock-thermometers in the grounds of the Edinburgh Royal Observatory, and to the deduction therefrom of three supra-annual cycles of temperature, one of which agrees remarkably in duration, though not in manner, with the spotted period of the sun.

The Edinburgh Astronomer, whose official residence has hitherto been at the foot of the hill, has, this last year, to thank Her Majesty's Government for having generously exchanged that for a house halfway up the hill, and commanding so excellent a view north, and east, and west, that he was enabled to begin a series of private spectroscopic observations during this last winter and spring on both the aurora, the zodiacal light, and the parts of the heavens where they usually appear. The results (astronomical chiefly) up to the present time have just been communicated to the Royal Astronomical Society, but possess some distinct meteorological applications as well.

RADCLIFFE OBSERVATORY, OXFORD. Rev. R. Main, M.A., F.R.S., &c.—The observations made during the past year have been precisely of the same character as in former years, and the reductions of the observations of previous years have been pursued to the same extent, and are complete to the end of 1868. As was noticed in the Report of last year, it has not been found possible to gain any advance in this respect, though it is considered highly desirable to do so from the importance of the results which are being developed from year to year. In the autumn of last year the Observatory sustained another serious loss from the death of the second assistant, Mr. Bechaux; though no actual interruption took place in the meteorological observations, yet it necessarily hindered the progress of the reductions till his place was supplied by Mr. G. Keating, of the Royal Observatory, Greenwich.

Very few additions or alterations in the instruments have taken place; but it may be mentioned that simultaneous readings have been made since 1870, April 1, of the standard thermometer with the thermometers which are placed at the top of the tower at 10 A.M. every day except Sundays. It may also be mentioned that, at the commencement of the present year, the photographic records of the direction of the wind were necessarily suspended for a few days, while a new endless screw was applied to the racked circle connected with the vane.

It may be desirable to draw attention to some of the most striking of the results which have been already deduced from the Oxford meteorological observations, chiefly with a view of inviting the cooperation of other observatories which may be furnished with suitable self-registering instruments and a sufficient staff of assistants to undertake the necessary computations.

First, with regard to the observations of solar radiation, it has been clearly shown that the yearly amount is variable, and has a period equal to that of the frequency of the solar spots; but (according to the opinion of Mr. Baxendell) the mean annual temperature shows no such variation. This is, however, contrary to the result arrived at recently by Mr. Stone at the Cape Observatory, who has satisfied himself that there is a well-marked period of mean annual temperature agreeing with that of solar-spot frequency.

Secondly, with regard to the anemographic observations, several important results deduced from them may be pointed out.

The first is the law of diurnal change of velocity and direction of the wind, which has been deduced with very great accuracy from the observations commencing with 1857, and from which Mr. Baxendell has drawn some very important conclusions, which deserve verification by means of observations made at other observatories.

The second is the law of change of the mean yearly direction of the wind, which strictly follows the cycle of solar-spot frequency, as will be seen from the following numbers, in which the angles are measured from the south towards the west, and represent the mean directions of the wind for the respective years:—

1859	S. $53\frac{1}{2}$ W.	1864	S. 20 W.
1860	$70\frac{1}{2}$	1865	16
1861	51	1866	$12\frac{1}{2}$
1862	$51\frac{1}{2}$	1867	24
1863	41	1868	38

The year 1860, when the wind had its extreme westerly direction, was a year of maximum solar-spot frequency, and the year 1866 was the corresponding year of minimum frequency; and the progress of the numbers from extreme westerly to extreme southerly direction of the wind, and back again, is so regular, that no doubt can exist of the fact of the relation.

These facts are mentioned with a view of showing the necessity, if meteorology is to take its place (as now seems probable) amongst the exact sciences, of a much more elaborate reduction and discussion of the observations made at different stations furnished with self-registering instruments, and of inviting the cooperation of other establishments for the deduction of similar results to those given above.

CAMBRIDGE OBSERVATORY. Prof. J. C. Adams, LL.D., F.R.S., &c.—The meteorological labours at this Observatory for the past year consisted of the daily readings, at 9^a A.M. and 3^a P.M., of the barometer, dry- and wet-bulb thermometer, anemometer, and rain-

gauge. The instruments having acted satisfactorily throughout the year, no change has been made in them.

The observations have been reduced by Glaisher's Hygrometrical Tables, and a quarterly and yearly summary sent to the 'Cambridge Chronicle' and to Mr. Symons.

The amount of rain for the year was 14.251 inches in 130 days, being 6.4 inches below the average.

An unusual number of fine displays of auroras have been observed.

The nights for observing meteors in August and November were unfavourable.

BIDSTON OBSERVATORY, LIVERPOOL. John Hartnup, F.R.A.S., &c.—The meteorological instruments and arrangements for taking observations were precisely the same as during the preceding year. This Observatory was not originally furnished with self-registering meteorological instruments; but their erection was subsequently urged upon the authorities of Liverpool by merchants and scientific men resident in the town, applications being often made for different meteorological particulars. The Director, in his Annual Report, publishes the daily results of the meteorological observations for each month, in addition to which the monthly results are published in the Registrar-General's 'Quarterly Report;' in all other respects the same remarks are applicable to the year under notice as to the year 1869-70.

THE COLLEGE OBSERVATORY, STONYHURST. Rev. S. J. Perry, M.A., F.R.A.S., F.M.S.—The two independent series of meteorological observations have been continued as usual during the past year, and a set of comparison readings of the dry- and wet-bulb thermometers have been taken to determine the corrections to be applied to the instruments and stations, in order to connect the two series.

The self-recording instruments of the Board of Trade were increased this year by the addition of a Beckley rain-gauge, which has been in constant action since the end of March. It is placed between the two gauges formerly in use.

The monthly determinations of the magnetic elements, and the photographic records of the three magnetographs, have never been interrupted.

A paper on the results of seven years' observations of the monthly values of the magnetic elements, read before the Royal Society, appears in the 'Philosophical Transactions' for this year. The deduced secular variations of the horizontal force and of the dip are $+0.0042$ and $-1' 49''.2$ respectively.

THE METEOROLOGICAL OFFICE. Robert H. Scott, M.A., F.R.S., Director.—The work of the Office is divided into three general branches. 1. Ocean meteorology, comprising the investigation of the meteorological conditions of the entire ocean by means of observations made with standard instruments furnished for the purpose; 2. Telegraphic weather-intelligence, for the preparation of the daily weather reports, and for the issue of information of storms to our own ports and to some foreign countries; and 3. Land meteorology of the British islands, comprising continuous observations made by self-registering instruments at the several observatories established by the Meteorological Committee.

In the work of ocean meteorology the conditions of the district lying between 20° N. and 10° S. in the Atlantic (including the belt known as the equatorial Doldrums) are now being thoroughly investigated on the principles explained in the Report of the Office presented to Parliament in 1867. The extraction of the materials from the documents in the Office is in an advanced stage, and it is hoped that the discussion may be commenced by the close of the present year. It is confidently expected that the results of the investigation will, when published, materially shorten the passages of ships over this much-frequented district.

In branch 2 the system of weather telegraphy, as modified from that formerly adopted by Admiral FitzRoy, has been maintained and rendered more efficient. The Office is in receipt of daily telegrams from numerous stations at home and abroad, and issues telegraphic information of storms to our own ports *free of charge*, on their undertaking to bear the local expenses for keeping the signal-apparatus in repair. The number of stations now receiving the intelligence is 108. Warning messages are also sent to foreign countries in exchange for information of a similar nature. A copy of the Daily Weather Report is also sent to all sea-ports that wish for it, for exhibition to those interested. Under this head it may be mentioned that a new edition of the Board of Trade 'Barometer Manual' has been issued, having been entirely rewritten. The work contains much valuable information, and copies have been widely distributed to sea-faring communities, and for use in conjunction with the "Fishery" or coast barometers supplied by the Office. The number of such instruments issued up to the present time is 113.

The objects of the third branch, viz. land meteorology, are, first, to afford for these islands accurate meteorological information, similar to that published under Government auspices in most other European countries, but based on continuous automatic records; and, secondly, to furnish data for placing the system of "Telegraphic Weather Intelligence" on a satisfactory scientific basis. Seven observatories have been established and furnished with self-recording instruments, described in the Report for 1867, and including the recently invented self-registering rain-gauges. The stations are Aberdeen, Armagh, Falmouth, Glasgow, Kew,

Stonyhurst, and Valencia. Anemographs have also been erected at Holyhead, Orkney, and Yarmouth. The results are published in the Quarterly Weather Report of the Office, and contain the complete reproduction of the photographic and other records of the instruments, produced by means of delicate pantographs invented by Francis Galton, Esq., and Herr Wagner, of Berlin (see Parliamentary Report for 1870). The plates admit of accurate measurements for the determination of the readings at any epoch. These are accompanied by the text, containing a general account of the chief features of the weather for the period in question, obtained from every source at the command of the Office, including ships' logs, and also by tables giving mean numerical results. The Office is indebted to the kindness of several gentlemen for traces of records made with self-recording instruments at various other stations besides those above mentioned; and it also receives reports of eye-observation from many well-known observers who have volunteered to assist in the general work and who are supplied with register-forms for the purpose. The results hitherto published in this branch embrace the observations for the year 1869 and the first quarter of 1870, with tabular results for the year; and the arrears of work are being steadily cleared off.

CEYLON.—Two years have now expired since the establishment of the meteorological station in this island was noticed in our Annual Report. On the last occasion we mentioned that there were thirteen stations returning more or less complete returns, and, in addition, fourteen stations from which the rainfall returns only are sent in. By the end of February of the present year, the thirteen had decreased to twelve, but the fourteen had increased to sixteen, thus giving a total of twenty-eight stations distributed through the island. From the observations made at the twelve stations during the period April 1870 to February 1871, we give the following extracts:—

		Station.
Maximum shade-temperature...	100°6 (May) ...	Batticaloa.
„ sun-temperature.....	168°0 (Nov.) ..	Ratnapura.
	in.	
Largest daily rainfall	8·03 (Nov.)..	Wihāragalla.
„ monthly rainfall	36·23 (Oct.)...	Colombo.

At Puttalam, during the month of May 1870, the mean daily horizontal movement of the air was 442·8 miles. These few particulars give us a slight idea of the extraordinary character of the different meteorological elements which are noted down under the general directorship of Col. J. G. Jervois, R.E., by whose direction the returns are printed in monthly sheets.

BARBADOES.—A paper has been written by an inhabitant in relation to the rainfall of this island, giving the averages of the monthly and yearly falls, for series of years, varying at different stations between 1847 and 1869. The author, in his opening remarks, speaks of the kindness of His Excellency the Governor for the great interest he has shown to advance meteorological science, also the unsuccessful endeavours to obtain assistance from the Imperial Government in the formation of a meteorological office in this island, a complaint which is universal.

On inspecting the Table of the Rainfall, it will be seen that the island has been divided into six districts, which represent with sufficient accuracy the geographical and pluviometrical differences of the island; and although it would have been more satisfactory if the returns of the rainfall sent in had all embraced the same number of years, yet the number of stations (50) on which the *averages have been calculated* is sufficiently large to furnish data for future calculations, and to give a very fair idea of the actual average rainfall of the parishes and districts of the island. In the 1st district (Windward Below Cliff) there are 10 stations, in the 2nd (Windward Highland) there are 9, in the 3rd (Central Highland) there are 15, in the 4th (Leeward Lowland) there are 21, in the 5th (Central Lowland) there are 13, and in the 6th (Southward Lowland) there are 35 stations.

The monthly and yearly averages of the different districts have been calculated from the monthly and yearly totals of the parishes forming the districts; and from calculations made of the percentage of rainfall in each district in each month during the period embraced in the Table, it appears that in average years one-eighth of the rainfall occurs in the first quarter of the year, one-fifth in the second quarter, one-third in the third quarter, and the remainder (rather more than one-third) in the last quarter of the year; and the rainfall is distributed over the different districts during the four quarters of the year in the following proportions:—

First quarter.—The rainfall is above the average in the Central Highland, and is about the average in the remaining districts, with the exception of the Southward Lowland, where it is below.

Second quarter.—The rainfall is below the average in the Central Highland and Central Lowland; about the average in all the others, with the exception of 1 and 2, where it is above.

Third quarter.—The rainfall is above the average in the Leeward and Central Lowland; is below the average in the Windward Below Cliff and Windward Highland; is about the average in the others.

Fourth quarter.—The rainfall is above the average in the Southern Lowland; is below the average in the Central and Leeward Lowland; is about the average in the others.

MAURITIUS, Meteorological Society of.—At the Meeting of

this Society on the 23rd of March last, it was announced by the President that the temporary Observatory had been removed to the vicinity of the Magnetical Observatory at Pampelmousses. The foundation-stone of the main building of the new Observatory had been laid by H.R.H. the Duke of Edinburgh on the 30th of May, 1870; but, owing to the want of funds, no step had since been taken to raise the superstructure. A small separate building, however, which was a part of the general plan, and was intended for a Magnetical Observatory, had been nearly finished, and the instruments were being put in place. The main building was intended for the astronomical and meteorological instruments, and it was its non-completion which rendered it necessary to hire a building as a temporary arrangement. Observations of rainfall were taken at nearly thirty stations, at some of which barometrical and thermometrical observations were also taken. A paper was read by Charles Meldrum, F.R.A.S., F.M.S., the Secretary of the Society, upon the Rainfall of Mauritius, and was a discussion of the rainfall which had taken place in the colony since 1867, in continuation of the paper which was read before our own Society at the June Meeting of 1861; but the whole period of observations was much too short to elicit any satisfactory results.

QUEENSLAND, AUSTRALIA. E. MacDonnell, Government Meteorological Observer.—The Government of this Colony, being desirous of obtaining an accurate and scientific knowledge of its climate, have decided upon the establishment of stations for the purpose of meteorological observations at the various parts of the Colony where it is believed the greatest variations of climate may be met with; so that, by a series of regular and careful observations simultaneously carried on, the desired result may be obtained. Meteorological observations have been regularly taken and recorded at Brisbane for the past nine years, and twelve other stations have been established within the last two years; meteorology is therefore fairly represented in this remote part of the world.

SOUTH AUSTRALIA. Charles Todd, F.R.A.S., Government Meteorological Observer.—In this Colony there were no less than thirty-one stations established at the end of the year 1869, the principal station of which is Adelaide, where the observations extend over a period (at the end of 1870) of nine years, those at the other stations comprising series of from two to four years. In preceding numbers of the Proceedings of this Society, tabulated results of the observations taken at the Adelaide Observatory have been published from time to time, and from these it would appear that the mean yearly temperature is about $63^{\circ}7$, and the mean

rainfall 19.25 inches; but with respect to these and other meteorological elements much longer series of observations are required to speak with any degree of certainty.

NEW ZEALAND.—Monthly Abstracts of Meteorological Observations to the end of November 1870 have been received from this Colony. There are at present eleven stations in the island, being the same as at the end of last year. The Annual Statistical Report for 1869 has also been issued, and from it we extract a few particulars:—

“During the year 1869 the mean pressure of the atmosphere was greatest at Mongonui, with 30.000 inches, and least at Bealey, with 29.760 inches; the highest and lowest readings at any station were 30.578 inches and 28.701 inches respectively, and were both registered at Taranaki, thus giving this station the greatest range of readings, viz. 1.877 inch. The maximum reading of the shade thermometer was 88° 8 (at Christchurch, in January), and the sun-thermometer was 163° (at Southland, in December); the mean temperature of the year was 60° 6 at Mongonui (70 feet above sea-level), whilst at Dunedin (550 feet) and Southland (79 feet) it was 50° 8 and 50° 9 respectively. The rainfall at Hokitika (12 feet above the level of the sea) amounted in the year to 88.210 inches, whilst at Dunedin (550 feet) it amounted to 32.918 inches only: taking the daily falls, Auckland is first, with 6.39 inches, Nelson being second, with 5.20 inches; whilst in the monthly falls, Bealey, with 15.47 inches in October, is closely followed by Auckland with 14.15 inches.”

BRITISH RAINFALL INVESTIGATIONS.—There is hardly any class of phenomena for the successful investigation of which uniformity of practice and continuity of observation are so important as they are in the measurement of rain. Hence, in saying that there has been no change in the system of registration, none in the publication, and that the interrupted records (from all causes, deaths, removals, &c.) are not two per cent. of the continuous ones, we are quoting the best evidence of progress.

It was mentioned last year that the whole of the experimental rain-gauges used at Calne, and many of those from Strathfield Turgiss, were sent to the Rev. F. W. Stow, M.A., F.M.S., of Hawsker, near Whitby, who worked them most carefully during 1870, and has reported very fully upon them in ‘British Rainfall,’ 1870, so that it is unnecessary to dwell at any length upon the results. One curious fact may, however, be mentioned. It will be in the remembrance of those who have closely followed recent rainfall experiments that, at Rotherham, Mr. Chrimes

has a gauge of which the receiving-surface is vertical, and which, by a vane, is kept full face to the wind. He has also, at the same height above the ground, an ordinary horizontal-mouthed gauge. Evidently the ratio between the amounts collected by these two gauges indicates the angle of falling rain. Again, it is well known that the amount of rain collected by ordinary horizontal-mouthed gauges decreases with the elevation of the gauge above the surface of the ground. Mr. Stow had six gauges specially prepared, three with their orifices horizontal, and three with them vertical and governed by vanes. He placed one of each at three different heights, namely 1 foot, 5 feet, and 10 feet above the ground. As will be expected, his ordinary gauges followed the ordinary rule, and the higher ones collected less than the low one; but in every instance the *reverse was the case* with the vertical gauges, so that the sum of each pair of gauges was nearly identical, and irrespective of their height above the ground.

During the autumn of 1870 Mr. Symons spent some time in erecting gauges in the Peak of Derbyshire, in which he was zealously assisted by Mr. E. J. Sykes, F.M.S., of Buxton, and by Mr. Hazlewood, of Castleton. The result of their joint labours has been the erection of one additional gauge to the south of Buxton, one on Mam Tor (1680 feet above sea-level), several others round Castleton, and one at Bamford near Hathersage, where a few observations were made between 1839 and 1841. Having done thus much, it is to be hoped that those who have friends or property in the district will assist in obtaining observers in the few villages where observations are still required to complete the examination of the district.

TEMPERATURE OF THE EARTH AT GREAT DEPTHS.—The experiments at the deep bore on the southern slopes of Highgate Hill have been continued by Mr. Symons and completed, the results throughout the entire depth of 1100 feet being so strictly accordant as to render further repetition, with present appliances, a sheer waste of time. It is worthy of consideration whether it would not be a useful experiment to have a thermometer of extreme delicacy (say one inch of scale to each degree), but short range (say 65° to 71°), kept permanently at 1000 feet below the surface, read monthly and verified yearly.

The following is a Tabular Statement of the present strength of the Society:—

	Fellows.			Totals.
	Life.	Ordinary.	Honorary.	
1870, June 15	69	264	8	341
Since elected	...	+ 13	...	+ 13
Since compounded ...	+ 5	— 5	...	0
Deceased	— 1	— 4	...	— 5
Retired	...	— 3	...	— 3
Defaulters	...	— 6	...	— 6
1871, June 21	73	259	8	340

During the past year we have suffered a great loss in the deaths of five of our Fellows, four of whom were well known in the scientific world; the deceased Fellows are:—

GEORGE HUNSLEY FIELDING, M.D., who was elected into the Society on March 16, 1870.

J. S. FOURDRIER, elected June 18, 1862.

CHARLES FRODSHAM, F.R.A.S., elected June 8, 1859.

Rt. Hon. Sir FREDERICK POLLOCK, Bart., M.A., F.R.S., F.R.A.S., late Pres. Photo. Soc. Lond., F.S.A., F.G.S., elected May 27, 1851.

Rev. JOSEPH BANCROFT READE, M.A., F.R.S., F.R.A.S., Pres. R.M.S., M.P.S. Lond., elected April 8, 1850.

CHARLES FRODSHAM was born on the 15th of April, 1811, and was the third son of the late Mr. W. J. Frodsham. Trained to his father's business (chronometer- and watch-maker), he showed whilst yet young a remarkable faculty for undertaking the more minute and intricate calculations involved in the construction and regulation of chronometers. In 1862 Mr. Frodsham was appointed a Juror in Class XV. in the London International Exhibition, and being elected Reporter to the same, he published a very exhaustive report on Chronometers, Watches, and Clocks. He was also, in this same year, the author of a treatise entitled 'A few Facts connected with the Elements of Clock- and Watch-making.' Mr. Frodsham served twice as master of the Clock-maker's Company. He was appointed a Juror of the Dublin Exhibition in 1865, and also both a Juror and Vice-President of the Paris Exhibition in 1867; although excluded by his position as

Juror from all competition on these occasions, he gained eleven medals, among which was the gold medal of the Emperor of Russia.

Mr. Frodsham was elected a Fellow of the Royal Astronomical Society in April 1833, and in April 1847 was presented with the Telford Medal for a paper on the "Isochronism of the Balance-spring," at the same time receiving the compliment of being made an Associate of the Institute of Civil Engineers; he was elected a Fellow of the Meteorological Society in June 1859.

As an English watch-, clock-, and chronometer-maker he is justly entitled to rank as one of the most distinguished instrument-makers of the age in which he lived, and his name will ever be most honourably associated with his particular art throughout the civilized world. He died on the 11th of January, 1871.

The Right Hon. Sir F. POLLOCK, Bart., was the third son of Mr. David Pollock, and was born in London on September 23rd, 1783. Educated at St. Paul's School, he went from there to Trinity College, Cambridge, where he greatly distinguished himself, and became Senior Wrangler in the year 1806. In the following year, having chosen the law as his profession, he was called to the bar, where he rapidly obtained an extensive practice, and in eleven years from the time of his leaving college he received a silk gown. For many years he led the northern circuit, and was retained in all the most important cases. From 1831 to 1844 he represented the borough of Huntingdon in the House of Commons, and was promoted, under Sir Robert Peel's administration, to the office of Attorney-General. In the year 1844 he succeeded the late Lord Abinger in the high position of Lord Chief Baron of the Court of Exchequer, from which office he retired in June 1866, when he was created a Baronet. Sir Frederick was a member of many of the learned Societies, being elected a Fellow of the Royal Society in February 1816, of the Royal Astronomical Society in May 1849, and of the Meteorological Society in May 1851; in the Photographic Society of London he held the office of President for nearly fourteen years, having succeeded the late Sir Charles Eastlake in 1855.

Although his mind was necessarily, to a great extent, absorbed by the duties of his office, Sir Frederick never lost his interest for mathematical and general science; his reading, in most branches of human knowledge, was extensive and profound, and he ever evinced a lively interest in the most recent scientific investigations. Within a few weeks of his death he was engaged on a mathematical paper, which he intended to communicate to the Royal Society. Photography was a favourite science with him, and he was active in promoting the interests of the Photographic Society, over whose meetings he presided.

Sir Frederick was twice married, and has left a family of twenty children. Several of his sons have already distinguished them-

selves. The present Sir Frederick is one of the Masters of the Court of Exchequer.

The late Sir Frederick Pollock died at Hatton on the 22nd of August, 1870, in his 87th year.

The Rev. JOSEPH BANCROFT READE, M.A., F.R.S., was born on the 5th of April, 1801, at Leeds in Yorkshire, and received his elementary education at the grammar school of that town. He subsequently matriculated at Trinity College, Cambridge, when he was elected to a scholarship at Caius College, graduating B.A., as Senior Optime, in 1825, and M.A. in 1828, and was successively appointed Vicar of Stone, near Aylesbury, and Rector of Bishopsbourne, near Canterbury, which living he held at the time of his death.

From his early years he had a strong liking for microscopy and photography; and his paper in connexion with the former science mainly contributed to his being elected a Fellow of the Royal Society in February 1838, about which time he drew the special attention of microscopists to the great value of black-ground illumination, which has since gone by his name. January 29, 1840, will always hold a place in the history of the microscope as being the day on which the Royal Microscopical Society was founded, by the meeting of a few gentlemen, amongst whom was the subject of this memoir, who took a great interest in the Society up to the time of his lamented decease, when he occupied the honourable position of President.

In 1838 he was elected a Fellow of the Royal Society, and on April 8, 1850, was one of the founders of this Society, on the Council of which he served from 1851-55, and was elected to serve during the Session 1870-71; he also held the position of Vice-President from 1855-57, and was Vice-President of the Photographic Society of London. But microscopy was his favourite subject, and it is in relation to this science that we find most of his papers, among which were:—"On the Existence of Structure in the Ashes of Plants, and their Analogy to the Osseous System of Animals," communicated to the 'Philosophical Magazine' in July 1837; "On the Chemical Composition of Vegetable Membrane and Fibre," originally read at the meeting of the British Association in 1837, but published in the November number of the 'Philosophical Magazine' for that year; "On some new Organic Remains in the Flint of Chalk" in the 'Annals and Magazine of Natural History,' 1838, vol. ii.

In the first volume of the 'Transactions of the Microscopical Society' is a paper which he read before the Society, headed "The Process of charring Vegetable Tissue as applied to the examination of the Stomata of Garden Rhubarb;" and in two communications to the Society, in 1842, he drew attention to the great assistance which chemistry might derive from the use of the microscope, and goes on to state that a quantity of nitrogen, not

exceeding the $\frac{1}{10,000}$ part of a grain, if existing as a constituent of ammonia, may be detected with certainty by means of this instrument, and pointed out that ammonia was a product of respiration, a fact which did not obtain credence at the time, though justice was subsequently done to him on this point by Dr. Richardson, in his prize-essay on the coagulation of the blood. These and other papers, too numerous to mention, were contributed to the Royal Microscopical Society or the British Association.

At the Exhibition of 1851 he exhibited an astronomical eyepiece, of his own invention, called a solid eyepiece, which was thought so highly of as to merit Special Mention.

The subject of illumination in microscopic research was always a favourite study with him, and he has often been heard to say that the microscope was nothing without it; and it was from having this subject so constantly before him that he was led to the discovery of the value of a parallel beam of light in determining the true structure of the markings in diatoms and other minute objects. In June 1869 he read a paper before the Royal Microscopical Society descriptive of the prism which now goes by his name, the value of which cannot be over-estimated; for this inexpensive simple appliance gives results which are not surpassed by any of the numerous contrivances of Wollaston, Brewster, Amici, and others, or even his own favourite kettledrum, with flute-key adjustment. Dr. Donkin, who is now engaged in writing the 'Natural History of the British Diatomaceæ,' bears testimony to the great value of the prism in the examination of these interesting objects. Such is a slight sketch of the published labours of the late Mr. Reade in connexion with the microscope, and he will be long remembered by all who knew him for his kind and genial disposition and his readiness to impart from the rich stores of his knowledge any information he possessed. He died on the 12th of December, 1870, in the seventieth year of his age.

The following is a List of the Papers which have been read at the Ordinary Meetings of the Society during the Session 1870-71:—

At the NOVEMBER Meeting, 1870.

1. "On Evaporation and Evaporation-gauges, with some Remarks upon the Formation of Dew." By George Dines, F.M.S.
2. "On a Storm at Calcutta, followed by a remarkably Hot and Dry Wind." By Lieut.-Col. J. F. Tennant, R.E., F.R.S., F.M.S.
3. "The Auroræ Boreales of September 24 and October 24th and 25th, 1870." By different Observers.

At the JANUARY Meeting, 1871.

4. "Heights and Velocities of Shooting-Stars observed in England in August 1870." By Prof. A. S. Herschel, B.A., F.R.A.S.
5. "On the Remarkable Period of continuous Cold Weather from 1870, December 21st, to 1871, January 5th." By James Glaisher, F.R.S., Secretary.
6. "Meteorological Observations in 1869, at Martendale, Southland, New Zealand." By Charles Rous Marten, F.M.S.
7. "Description and Figure of Mr. Cator's Anemometer as arranged with Spiral Apparatus."

At the FEBRUARY Meeting, 1871.

8. "Influence of the Moon upon the amount of Rainfall." By John Charlton Bloxam, M.R.C.S., F.M.S.
9. "On Professor Poey's New Classification of Clouds." By Robert James Mann, M.D., F.M.S.
10. "The Aurora Australis of October 23 and 24, 1870." By Robert James Mann, M.D., F.M.S.
11. "Mean Temperature of the Air at Osborne, Isle of Wight, as deduced from Observations taken during the years 1858-69 (inclusive)." By James Robert Mann.
12. "Eclipse of the Sun, 1870, December 22, as observed at Culloden." By Arthur Forbes, F.M.S.
13. "Meteorological Observations recorded in 1869 at the Adelaide Observatory, South Australia." By Charles Todd, F.R.A.S.

At the MARCH Meeting, 1871.

14. "On Evaporation, Rainfall, and Elastic Force of Vapour." By James B. Mann.
15. "Abstract derived from Meteorological Observations made at the British Cemetery, Scutari, Constantinople, in the years 1865-69."
16. "On the Temperature of the Dew-Point." By George Dines, F.M.S.
17. "On a New Electro-Magnetic Anemometer." By John J. Hall, F.M.S.
18. "Results of Meteorological Observations taken at the Observatory, Adelaide, South Australia." By Charles Todd, F.R.A.S.

At the APRIL Meeting, 1871.

19. "On Deep-Sea Thermometers." By Captain J. E. Davis, R.N., F.R.G.S.
-

The President having appointed Messrs. Marriott and Field as Scrutineers, a ballot was then taken, and the following list of Fellows, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the twenty-third Session, 1871-72:—

THE OFFICERS AND COUNCIL

OF

THE METEOROLOGICAL SOCIETY,

ELECTED 21st OF JUNE, 1871.

President.

JOHN W. TRIPE, M.D.

Vice-Presidents.

NATHANIEL BEARDMORE, C.E., F.R.A.S., &c.

CHARLES O. F. CATOR, M.A.

GEORGE JAMES SYMONS.

CHARLES VINCENT WALKER, F.R.S. &c.

Treasurer.

HENRY PERIGAL, F.R.A.S., 9 *North Crescent, Bedford Square, W.C.*

Trustees.

SIR ANTONIO BRADY, F.G.S.

STEPHEN WILLIAM SILVER.

Secretaries.

CHARLES BROOKE, M.A., F.R.S., &c., 16 *Fiteroy Square, W.*

JAMES GLAISHER, F.R.S. &c., 1 *Dartmouth Place, Blackheath, S.E.*

Foreign Secretary.

LIEUT.-COL. ALEXANDER STRANGE, F.R.S. &c., 41 *Brompton Crescent, S.W.*

Council.

ARTHUR BREWIN, F.R.A.S.

GEORGE DINES.

FREDERICK W. DOGGETT.

HENRY STOKES EATON, M.A.

FREDERICK GASTER.

REV. CHARLES H. GRIFFITH, M.A.

ROBERT JAMES MANN, M.D., F.R.A.S., &c.

W. WILSON SAUNDERS, F.R.S. &c.

ROBERT HENRY SCOTT, M.A., F.R.S., &c.

THOMAS SOPWITH, M.A., F.R.S., &c.

SAMUEL CHARLES WHITBREAD, F.R.S. &c.

F. O. WILDMAN WHITEHOUSE.

The Treasurer's Account for the year 1870.

		<i>Receipts.</i>					
1870.					£	s.	d.
Jan.	1. To Balance of last year						
April.	Dividend on £1000 New 3 per Cents				14	13	9
Oct.	Do. do. do.				14	15	0
DIVIDENDS					29	8	9
					£	s.	d.
Subscriptions for 1866					1	0	0
Do. for 1867					4	0	0
Do. for 1868					12	0	0
Do. for 1869					37	0	0
Do. for 1870					175	4	0
SUBSCRIPTIONS					229	4	0
Feb.	8. Capt. R. R. Branfill				10	0	0
	24. A. North, Esq.....				10	0	0
Oct.	21. F. Gaster, Esq.				10	0	0
	24. Ch. Coppock, Esq.				10	0	0
Dec.	14. Ar. J. Melhuish, Esq.....				10	0	0
COMPOSITIONS					50	0	0
CONTRIBUTIONS					279	4	0
					308	12	9
June 30.	Sales of Proceedings, &c.				6	0	2
Dec. 31.	Do. do.				7	3	9
SALES					13	3	11
RECEIPTS					321	16	8
					£359	10	0

The Treasurer's Account for the year 1870.

<i>Expenditure.</i>			
		£ s. d.	£ s. d.
1870.			
Jan. 19.	By Proceedings, No. 46.....	19 13 3	
Feb. 16.	Do. No. 47.....	26 0 0	
Mar. 16.	Do. No. 48.....	25 17 0	
April 20.	Do. No. 49.....	12 0 0	
June 15.	Do. No. 50.....	27 10 9	
Nov. 16.	Do. No. 51.....	30 5 3	
	PROCEEDINGS, Six Nos.....		141 6 3
	Dec. 31. Registrar-General's Reports, 4 quarters	5 12 0	
	PRINTING		146 18 3
	Nov. 17. Contributions towards the Expenses of the Learned Societies' Accommodation Committee	5 0 0	
	Dec. 31. Stationery	7 19 9	
	Postage Stamps	8 10 0	} 16 12 3
	Cheque Stamps	0 2 6	
	Petty Expenses of Secretary	3 19 6	} 4 8 8
	Do. of Librarian	0 9 2	
	Attendance, Refreshments, &c.....	8 11 0	
	EXPENSES		29 11 11
	Editor of Proceedings	52 0 0	
	Collector's Commission	11 9 0	
			63 9 0
	PAYMENTS		<u>£244 19 2</u>
	BALANCE		<u>114 10 10</u>
			<u>£359 10 0</u>

HENRY PERIGAL, *Treasurer.*

Examined with the Vouchers, and }
found correct, 13 June, 1871. } W. C. NASH, *Auditor.*

Resolved:—

That the Report just read be received and adopted, and that it be printed and circulated among the Fellows of the Society.

Proposed by R. H. Scott.

Seconded by G. J. Symons.

That the cordial and best thanks of the Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

Proposed by Sir A. Brady.

Seconded by G. Dines.

That the best thanks of the Society be given to the retiring President, C. V. Walker, Esq.

Proposed by J. W. Tripe.

Seconded by H. S. Eaton.

That the best thanks of the Fellows are due and be given to James Glaisher, F.R.S., and C. Brooke, F.R.S., Secretaries, for their constant efforts to promote the interests of the Meteorological Society on every occasion, and their regular attendance at the Meetings.

Proposed by H. S. Eaton.

Seconded by G. J. Symons.

That the best thanks of the Society are due and be given to H. Perigal, Esq., the Treasurer, and F. Gaster, Esq., Librarian, for their services during the past year.

Proposed by Dr. Tripe.

Seconded by R. H. Scott.

That the best thanks of the Society be given to W. C. Nash, Esq., for his excellent service to the Society as Auditor for a period of five years.

Proposed by J. Glaisher.

Seconded by C. O. F. Cator.

That it be referred to the Council to consider whether or not it be possible to improve the position of the Society with reference to the Government and the Public generally, and in especial relation to the "Aid to Science" Commission now sitting.

Proposed by Robert H. Scott.

Seconded by Sir Antonio Brady.

Resolved:—

That the Council be requested in preparing the annual Balloting List for Officers and Council to insert on it the names of twenty-six persons being Fellows of the Society, and also to print on the Balloting List a tabular statement of the attendances of the outgoing Council (including Officers) at the Council and Ordinary Meetings of the previous year.

Proposed by Rogers Field.

Seconded by C. F. de Kierzkowski.

NOTICE.**SESSION 1871-72.**

The Meetings will be held on the Third Wednesday in the months,
at 25 GREAT GEORGE STREET, WESTMINSTER, S.W.,

by the kind permission of

THE COUNCIL OF THE INSTITUTION OF CIVIL ENGINEERS.

COUNCIL MEETINGS at 6 P.M.

1871. October	18	1872. March	20
" November	15	" April	17
1872. January	17	" June	19
" February	21	" October	16

ORDINARY MEETINGS at 7 P.M.

1871. November	15	1872. March	20
1872. January	17	" April	17
" February	21	" June	19

The Annual General Meeting will be held after the Ordinary Meeting on June 19.

I N D E X.

A.

	Page
Abstract from Meteorological Observations made in the Colony of the Cape of Good Hope	84
— from Meteorological Observations made at Scutari	298
Account of Two Meteors seen at Bishopsbourne	21
Accounts of a Brilliant Meteor seen on November 6, 1869	22
Adelaide Observatory, Meteorological Observations in 1869 recorded at the	284
— —, Results of Meteorological Observations taken at the	304
Africa. The South-African Exploring Party	52
—, Rainfall in Natal	123
—, Temperature of the Air in Natal	150
—, Report upon Observations in Natal	184
Air, Sound in the Upper	25, 27
—, Temperature and Humidity of the, at heights of 22 feet and 50 feet above the ground	29
—, Temperature of the, Natal, South Africa	150
—, Mean Temperature of the, at Osborne	282
Airy, Osmund. The Aurora of February 11, 1870	78
Anemometer. Description and Figure of Mr. Cator's, arranged with Spiral Apparatus	263
—, New Electro-Magnetic	301
Annual General Meetings	167, 345
Astronomer Royal. Aurora Borealis of February 1, 1870	68
Atmospheric Pressure in relation to Wind and Rain	158
August Meteors. Heights and Velocities, 1870	243
Aurora Australis. October 23 and 24, 1870	281
— Borealis, Recent frequent appearance of the	67
—, February 1, 1870	68
—, February 11, 1870	77
—, February 12, appearing in Daylight	78
—, Seen in full Sunshine (1788)	80
—, Observed in Daylight (1799)	81
—, February 17, 1870	81
—, February 18, 1870	82
—, February 23, 1870	82
—, September 24, 1870	216
—, October 24, 1870	221
—, October 25 and 26, 1870	229
—, At Sea, off Gibraltar	239
—, Observed at Cramlington, October 25, 1870	240
Australia, Meteorological Observations made at the Adelaide Observatory	284, 304
—, Queensland. Report upon Meteorological Observations	361
—, South. Report upon Meteorological Stations	361

B.

	Page
Balance-Sheets.....	194, 370
Barbadoes. Report upon the Rainfall of the Island.....	360
Barber, W. Aurora Borealis of October 24, 1870.....	228
Barkly, Sir H. and Lady. November Meteors, 1869, in Mauritius .	162
Barometer, Error in Reading the Cistern-.....	10, 53
Birmingham, November Meteors, 1869, observed at	11
Bishop, W. Aurora Borealis October 24 and 25, 1870	228, 236
Bishopsbourne, Two Meteors seen at	21
Blight, R. Brilliant Meteor of November 6, 1869	23
Bloxam, J. C. Influence of the Moon upon the amount of Rain- fall	55, 269
Blythe, H. E. Results of Thirty Years' Observations (1840-69) at Burnham, Westgate, Norfolk	83
Bournemouth Meteorological Society, Report upon Proceedings of the	349
Brayley, E. W., Obituary notice of	186
Bristol, Meteorology of Clifton.....	196
—, Observations of Aurora at Over Court, near	78
British Rainfall Investigations, Report upon Progress of	362
Broadstairs, Brilliant Meteor seen at, November 6, 1869	23
Brumham, G. D. Laws which appear to regulate the Temperature of the Summer Months and Seasons.....	129
Burnham, Westgate, Norfolk, Results of Thirty Years' Observations at	83

C.

Calcutta, On a Storm at	213
Cambridge Observatory, Report upon Meteorological Observations at the.....	177, 356
Cann-Lippincott, R. C. Observations of the Aurora, February 11, 1870	78
Cape of Good Hope. Abstract from Meteorological Observations made in the Colony.....	84
Cator. Description and Figure of Mr. Cator's Anemometer as ar- ranged with Spiral Apparatus	263
Ceylon. Reports upon Meteorological Stations	185, 359
Chaplin, T. Rainfall at Jerusalem during the Rainy Season of 1868-69	50
Chapman, J. Brilliant Meteors of November 6, 1869	23
Chiswick, Daily Rainfall at	196
Cistern-Barometer, To find the Error in Reading the	10, 53
Clifton, Meteorology of	196
Clouds, Professor Poey's New Classification of	276
Cobham, Daily Rainfall at	196
Cold Weather, Remarkable Period of continuous	253
Constantinople. Meteorological Observations in the Years 1865-69	298
Cornwall, Report on Meteorology of West	350
Council, Members of	196, 369
Cramlington, Observations of Aurora of October 25, 1870, at	240
Cramp, R. Brilliant Meteor of November 6, 1869	23
Criswick, G. S. Aurora of February 1, 1870	69
Culloden. November Meteors, 1869	20
—, Eclipse of the Sun 1870, December 22	262
Cyclonic Storm	266

D.

	Page
Daily Rainfall at Cobham and Chiswick from 1826-65	136
Davis, J. E. Deep-Sea Thermometers	182, 305
Daylight Auroræ	78, 80, 81
Deep-Sea Thermometers	182, 305
Denza, F. Aurora Borealis of September 24, 1870	219
— Phenomena observed at Moncalieri	343
Devonshire, South. Brilliant Meteor of November 6, 1869	23
Dew-point, Temperature of the	299
Dines, G. Daily Rainfall at Cobham and Chiswick from 1826-65 ..	136
— On Evaporation and Evaporation-gauges, &c.	199
— Temperature of the Dew-point	299
Dublin, Royal Observatory, Report from the, 1870	176

E.

Earth, Temperature of the, at Great Depths	180, 363
Eclipse of the Sun, 1870, December 22	282
Edinburgh, Royal Observatory. Report on Meteorological labours ..	174, 354
Ellis, W. Aurora of February 1, 1870	68
England, Heights and Velocities of Shooting-Stars observed in ...	243
Error in Reading the Cistern-Barometer	10, 53
Evaporation and Evaporation-gauges	199
—, Rainfall, &c.	285
Exploring Party, The South-African	52

F.

Fall of Rain on every Day of the Year	87
Fielding, G. H. The Summer of 1868	1
Fireball. Path of the large, of November 6, 1869	139
Forbes, A. November Meteors, 1869	20
— Eclipse of the Sun, 1870, December 22	282
Frodham, C., Obituary Notice of	364

G.

Glaisher, J. Temperature and Humidity of the Air at the heights of 22 feet and 50 feet above the Ground, &c.	29
Glaisher, J. Recent frequent appearance of Auroræ	67
— The fall of Rain on every Day of the Year, from 1815-69 ..	87
— Remarkable Period of continuous Cold Weather from 1870, December 21, to 1871, January 5	253
Glasgow, November Meteors, 1869, observed at	17
Gibraltar, Aurora Borealis observed at Sea, off	239
Greenwich, Royal Observatory, November Meteors, 1869, observed at	12
— Observations of Aurora Borealis, 1870, February 1	68
— Magnetic Disturbances on 1870, February 1	76
— Observations of the Aurora of 1870, February 11	77
— Reports on Magnetical and Meteorological Instruments and Observations	171, 350
— Observations of Auroræ Boreales of October 24-26, 1870 ..	221

H.

	Page
Hall, J. J. New Electro-Magnetic Anemometer	301
Hawkhurst, Brilliant Meteor observed at, November 6, 1869	24
Heights and Velocities of Shooting-Stars	243
Herschell, A. S. November Meteors, 1869	17
——. Sound in the Upper Air when the Lower Air is still	25, 27
——. Path of the Large Fireball of November 6, 1869, 11 ^h 50 ^m P.M. .	139
——. Heights and Velocities of Shooting-Stars observed in Eng- land in August 1870	243
Hot and Dry Wind after a Storm at Calcutta	213
Humphrey, T. Brilliant Meteor of November 6, 1869.	24

I.

Influence of the Moon upon the amount of Rainfall	55, 269
Isle of Wight, Mean Temperature of the Air at Osborne	282
Italy. Aurora Borealis of September 24, 1870, at Moncalieri.	219

J.

Jerusalem, Rainfall at.	50
------------------------------	----

K.

Kew Observatory, Report from the, 1870	176
--	-----

L.

Large Fireball of November 6, 1869; its path	139
Laws which appear to regulate the Temperature of Summer Months and Seasons	129
Liverpool Observatory, Reports from the	177, 357
Lyne, W. H. The Weather of 1869 at Scutari.	61
——. Solar Halo observed at Scutari.	238

M.

Mackinnon, W. A., Obituary Notice of	188
Magnetic Disturbances at the Royal Observatory, Greenwich, February 1, 1870	76
Mann, R. J. Mean Temperature of the Air at Osborne, Isle of Wight	282
——. On Evaporation, Rainfall, and Elastic Force of Vapour	285
——. The Rainfall in Natal, South Africa	123
——. On the Temperature of the Air in Natal, South Africa, &c. . .	150
——. On Professor Poey's New Classification of Clouds	276
——. The Aurora Australis of October 23 and 24, 1870	281
Manners, R. H., Obituary Notice of	189
Marriott, W. The Aurora of February 1, 1870	72
——. Daylight Aurora of February 12, 1870	79
——. The Aurora of October 24, 1870	223
——. The Aurora of October 25, 1870	231
Marten, C. R. Meteorological Observations in 1869, at Martendale, Southland, New Zealand	258

	Page
Matthew, J., Obituary Notice of	180
Mauritius. November Meteors, 1869	161
—, Report on Observations made in	360
Mean Temperature of the Air at Osborne	282
Meetings, Lists of	197, 373
Meldrum, C. November Meteors, 1869	54, 161, 163
Meteor, Brilliant, seen on November 6, 1869	22
Meteorological Observations made in the Colony of the Cape of Good Hope (Abstract)	84
— in 1869 at Martendale, Southland, New Zealand	258
— at the Adelaide Observatory, South Australia	284, 304
— at the British Cemetery, Scutari, Constantinople, in the Years 1865-69	298
Meteorological Office, Report from the	358
Meteora. November 1869	11, 54, 161
—, Two, seen at Bishopsbourne	21
Moncalièri, Observations of Aurora of September 24, 1870, at	219
Moon, its Influence upon the amount of Rainfall	55, 269

N.

Nash, W. C. The Aurora Borealis of February 1, 1870	69
—, Auroræ Boreales of October 24, 25, and 26, 1870	221, 229
Natal, Rainfall in	123
—, Temperature of the Air in	150
—, Annual Report on Observations in	184
New Zealand, Meteorological Observations in 1869 at Martendale, Southland	258
—, Reports on Meteorological Stations and Observations in	185, 362
Norfolk, Results from Thirty Years' Observations (1840-69) at Burnham, Westgate	83
North, A. Meteorology of Clifton (Bristol) for the Quarter ending March 31, 1870	136
Northumberland, Observations of Aurora at Cramlington	240
Norwich Meteorological Society, Reports upon the State and Progress of the	181, 349
Notices of Meetings	197, 373
November Meteors	11, 54, 161
Nursing Rao. On a Cyclonic Storm	266

O.

Obituary	186, 364
Observatories, Proceedings of various	171, 350
Officers	196, 369
Osborne, Isle of Wight, Mean Temperature of the Air at	282
Over Court, near Bristol. The Aurora of February 11, 1870	78
Oxford, Radcliffe Observatory, Report upon Meteorological Observations at	176, 355
Ozone-observations	51

P.

Papers, Lists of	192, 367
Paris Observatory, Report upon Meteorological Observations at the	352

	Page
Penzance, Brilliant Meteor seen at, November 6, 1869	22, 23
Perry, S. J. November Meteors, 1869	14
Pietermaritzburg, The Temperature of the Air in Natal, South Africa, from Observations taken at	150
Poey, Prof. New Classification of Clouds	276
Pollock, Sir F., Bart., Obituary Notice of	365
Pressure, Atmospheric, in relation to Wind and Rain	158
Previté, Rev. W. To find the Error in reading the Cistern-Barometer, if not hung truly vertical	10, 53

Q.

Queensland, Australia, Report upon Meteorological Observations in ..	361
--	-----

R.

Rainfall at Jerusalem	50
—, Influence of Moon upon amount of	55, 269
— on every day of the Year	87
— in Natal, South Africa	123
—, daily, at Cobham and Chiswick	136
— Investigations, Reports upon	179, 362
Ramsgate, Brilliant Meteor seen at, November 6, 1869	23
Reade, Rev. J. B., Obituary Notice of	366
Réduit, Mauritius, November Meteors, 1869, at	162
Remarkable period of continuous Cold Weather (1870, December 21, to 1871, January 5)	253
Reports, Annual	167, 345
Resolutions	193, 197, 872
Royston, The Aurora of February 1, 1870, observed at	74

S.

Schultz, G. L. Auroræ of February 1 and 11, 1870	71, 77
—, Auroræ of October 24 and 25, 1870	226, 234
Scottish Meteorological Society, Report on Proceedings of the	347
Scutari, The Weather of 1869, observed at	61
—, Solar Halo observed at	238
—, Abstract from Meteorological Observations made at, in the Years 1865-69	298
Shooting-stars, Heights and Velocities of	243
Smith, B. W. The Aurora Borealis of September 24th, 1870.	216
Solar Halos	237, 238
Sound in the Upper Air when the Lower Air is still	25, 27
Spiral Apparatus to Mr. Cator's Anemometer	263
St. Petersburg, Report upon the Meteorological Publications of the Central Physical Observatory	184
Stonyhurst. November Meteors, 1869	14
— College Observatory, Annual Reports from	178, 357
Storm at Calcutta	213
—, Cyclonic	266
Strachan, R. Atmospheric Pressure in relation to Wind and Rain ..	158
Summer of 1868	1

	Page
Summer Months and Seasons, Laws which appear to regulate the Temperature of	129
Summerby, W., Obituary Notice of	182
Sun, Eclipse of the, 1870, December 22	282

T.

Temperature and Humidity of the Air at the Heights of 22 feet and 50 feet above the Ground	29
—, Laws which appear to regulate the	129
— of the Air in Natal, South Africa	150
— of the Air at Osborne, Isle of Wight	282
— of the Dew-point	299
— of the Earth at Great Depths, Reports upon Progress of the Investigations of	180, 363
Tennant, J. F. On a Storm at Calcutta, followed by a remarkably Hot and Dry Wind	213
Thermometers, Deep-sea	182, 305
Todd, C. Meteorological Observations recorded in 1869 at the Adelaide Observatory, South Australia	284
— Results of Meteorological Observations taken at the Observatory, Adelaide, South Australia	304
Tupman, G. L. Observations of the Aurora Borealis "at Sea," off Gibraltar, October 24th, 25th, 1870	239

V.

Verney, E. H. Solar Halo observed in the Gulf of Guinea	237
---	-----

W.

Weather of 1869 at Scutari	61
—, Remarkable period of continuous cold	253
Wind, Remarkably Hot and Dry, following a Storm at Calcutta....	213
Wind and Rain, Atmospheric Pressure in relation to	158
Wokingham, Aurora of February 11, 1870, observed at Wellington College	78
Wortham, H. The Aurora Borealis of February 1, 1870.....	74
Wright, T. Aurora Borealis of February 1, 1870.....	70
— Daylight Aurora of February 12, 1870	78
— Aurora Boreales, October 24th, 25th, 1870.....	222, 231

THE END OF VOL. V.

BAILEY'S PUBLIC CLOCKS

J. BAILEY and Co. manufacture Clocks of a most superior description, by
 steam-power at very reasonable prices.

Extracts from *Tormentilla* for Bailey's Torret-Choclos

Testimonial from the late Right Hon. the Earl of Rosse, F.R.S., F.R.A.S., &c., the eminent Astronomer.

I beg to say that the Church Clerk here requests that you, I believe, will receive them with
 (PLEASE PRINT NAME) NAME

I have much pleasure in stating that the clock constructed by Mr. Bayley has met with my entire approval.

I am happy to be able to speak very highly of the Korean Clock you made for me nearly three years ago. It does well, and has been very much admired during that time. If it could be of any service to you, I have no doubt that the inhabitants of this great mountain village would give it freely.

Yours in love,
W. M. ROBINSON

J. BAILEY AND Co. have five Departments, viz.:

L. THE BRASS FOUNDRY AND STEAM-FITTING DEPARTMENT.

[illegible]

8. All sorts of brass work is throwing.

2.—THE SMALL MACHINE DEPARTMENT

In this Department may be found the Patent Oil Tester, Bailey's Quick-Motion, Graham's Battery, New Improved Wrenston's Valve-Expansions, Porter, Black's, Smith's, Tapp's, and Dean's Truck-Pumps, Smith's and Graham's Steam-Engines, Winding Indicators, Wilson's Reels, Baldwin's Brakes, etc. Also, Dealers's Lists of Goods.

More than 200,000 people are threatened annually, they say.

3.—THE TURRET-CLOCK AND STEAM-GAUGE DEPARTMENT

[illegible]

4.—THE ENGINEER'S SUNDRY DEPARTMENT.

Every description of animal products for Customs, included in this Department, Miscellaneous, Fishery, In the Customs
Bysses, Iron, Brass, and Lead, Yarn, Spinning, Self-Facilities, and other sections. For other, see Bureau of Commerce
Inventions, published every year. Field, in.

5.—THE ELECTRIC-TELEGRAPH DEPARTMENT.

[illegible]

June 2011/Volume 14/Number 6

THE Economic Production of Heat in Relation to the Generation of Steam, by R. W. LITTLE, B.Sc., C.E., and an account of HALL'S PATENT SYSTEM, with instructions for the use of the apparatus, by the same author.

J. BAILEY and Co.,

ALBION WORKS, SALFORD, LANCASHIRE.

ESTABLISHED MORE THAN HALF A CENTURY

One of the grossest acts that can be performed by a man of wealth is to desert to Germany and a Pastor Church is his Parish Church, which may be done for \$250 to \$500.



